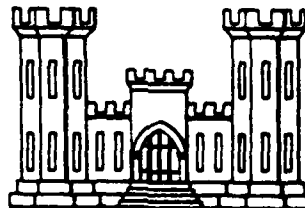LOWER HUDSON RIVER BASIN

GLENHAM DAM

DUTCHESS COUNTY, NEW YORK
INVENTORY NO. N.Y. 72

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

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NEW YORK DISTRICT CORPS OF ENGINEERS

AUGUST 1981

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Dutchess County
Lower Hudson River Basin

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization.

    Examination of available documents and visual inspection of the dam and appurtenant structures did not reveal any conditions which constitute an immediate hazard to human life or property.

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Using the Corps of Engineers' screening criteria, it has been determined that the dam would be overtopped for all storms exceeding 33 percent of the Probable Maximum Flood (PMF). Therefore, the spillway is adjudged as "seriously inadequate," and the dam is assessed as "unsafe, non-emergency."

Structural stability analyses based on available information, indicate that factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. The factor of safety against sliding was less than the recommended value of 3 for Cases 3 and 4. Therefore, when the dam is subjected to severe loading conditions such as a 1/2 PMF or PMF event, the factors of safety fall to below critical levels.

It is therefore recommended that, within three months of notification of the owner, detailed hydrologic and hydraulic investigations of the structure should be undertaken to more accurately determine the site-specific characteristics of the watershed and their effects upon the overtopping potential of the dam. At the same time, further analyses of the structural stability of the dam should be performed. Also, an in-depth study of the seepage and its effect on the brickwork of the dam must be performed. The results of these investigations and analyses will determine the appropriate remedial measures required. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Also, round-the-clock surveillance must be provided during these periods.

The regular inspections and maintenance procedures currently conducted by the owner's representative are inadequate. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually.

Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity or increase in flow.

The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training walls.

2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.

3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.

4. Repair the outlet pipe valve.

5. Repair the spalled and deteriorated concrete surface on the crest of the right side of the dam.

PREFACE

    This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

    In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

    It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

    Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GLENHAM DAM
I.D. No. NY 72
DEC DAM No. 212C-553, LOWER HUDSON RIVER BASIN
DUTCHESS COUNTY, NEW YORK

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APPENDIX

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Glenham Dam (I.D. No. NY 72)

State: New York

County: Dutchess County

Stream: Fishkill Creek

Date of Inspection: 8 March 1981

ASSESSMENT

Examination of available documents and visual inspec-
tion of the dam and appurtenant structures did not reveal
any conditions which constitute an immediate hazard to human
life or property.

Using the Corps of Engineers' screening criteria, it
has been determined that the dam would be overtopped for all
storms exceeding 33 percent of the Probable Maximum Flood
(PMF). Therefore, the spillway is adjudged as "seriously
inadequate," and the dam is assessed as "unsafe, non-
emergency."

Structural stability analyses based on available informa-
tion, indicate that factors of safety against overturning
are generally low, and the locations of the resultants fall
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loading conditions such as a 1/2 PMF or PMF event, the
factors of safety fall to below critical levels.

It is therefore recommended that, within three months
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investigations of the structure should be undertaken to more
accurately determine the site-specific characteristics of
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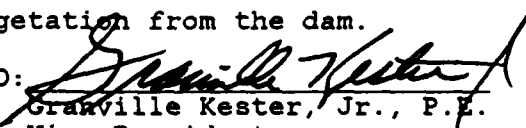
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Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity or increase in flow.

The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training walls.

2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.

3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.

4. Repair the outlet pipe valve.

5. Repair the spalled and deteriorated concrete surface on the crest of the right side of the dam.

6. Repair all spalled areas on the concrete surfaces of the dam.

7. Remove all vegetation from the dam.

SUBMITTED: _____
Granville Kester, Jr., P.E.
Vice President
MICHAEL BAKER, JR. of New York, INC.

APPROVED: _____
Colonel W.M. Smith, Jr.
New York District Engineer

DATE: _14 Aug 81_____

Overall View of Dam
Glenham Dam
I.D. No. NY 72
8 March 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
GLENHAM DAM
I.D. No. NY 72
DEC DAM No. 212C-553
LOWER HUDSON RIVER BASIN
DUTCHESS COUNTY, NEW YORK

SECTION 1:   PROJECT INFORMATION

1.1   GENERAL

a.   Authority - The Phase I Inspection reported herein
     was authorized by the Department of the Army, New
     York District, Corps of Engineers, to fulfill the
     requirements of the National Dam Inspection Act,
     Public Law 92-367.

b.   Purpose of Inspection - This inspection was conducted
     to evaluate the existing conditions of the dam, to
     identify deficiencies and hazardous conditions, to
     determine if these deficiencies constitute hazards
     to life and property, and to recommend remedial
     measures where required.

1.2   DESCRIPTION OF PROJECT

a.   Description of Dam - Glenham Dam is a concrete
     gravity structure 44.9 feet high and 312 feet
     long.   The dam is "L"-shaped.   The spillway crest
     is perpendicular to the concrete structure that
     comprises the right[1] side of the dam.   The right
     side of the dam is a complex concrete structure
     200 feet long with a crest width varying from 8.5
     feet to 24 feet.   The dam rises 27 feet above the
     ground surface of the right abutment with a set of
     concrete steps providing access to the top of dam.
     Some of the horizontal and sloping surfaces are
     capped with pre-cut stone slabs.   The concrete on
     some sections of the lower half of the dam has
     deteriorated revealing a brick wall about 8 inches
     behind the concrete surface.   The training walls
     above the downstream face of the spillway are made
     of large cut stone and a section of brick wall.

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[1]Looking downstream.

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The spillway is an ogee-shaped concrete weir 140 feet long (measured perpendicular to flow). The spillway has a rounded crest, a near vertical upstream face, and a downstream face with a slope of 1H:1V (Horizontal to Vertical). The left spillway training wall is formed by the left abutment's vertical rock face. The 11-foot high vertical concrete face of the dam forms the right training wall. The spillway discharges into a stilling basin which is 140 feet wide and 65 feet long. This basin is bound by the steep rock face of the left abutment and a 2-foot thick concrete training wall on the right side. At the downstream end of the stilling basin, water discharges over a 1-foot wide and 3-foot high rounded concrete end sill into the natural river channel.

There are four control valves on the crest of the dam. Three of these valves are located beside one another in a line near the center of the right half of the dam. These three valves control the water flow to Beacon Textile Printers, Ltd. The fourth valve is closer to the spillway crest and controls the valve on the 4.5-foot diameter brick-lined conduit that runs through the structure and discharges at the toe of the dam.

b. Location - Glenham Dam is located on Fishkill Creek, approximately 4200 feet northeast of Beacon, New York. The dam is located in Dutchess County, New York. The coordinates for the dam are N 41° 30.8' and W 73° 56.7'. The dam can be found on the Wappingers Falls, New York, USGS 7.5 minute topographic quadrangle. A location plan is included in this report in Appendix E.

c. Size Classification - Glenham Dam is 44.9 feet high and the reservoir storage capacity at the crest of the dam (elevation 189.6 feet M.S.L.) is 43 acre-feet. Therefore, the dam is in the "intermediate" size category as defined by the Recommended Guidelines for Safety Inspection of Dams (Reference 13, Appendix D).

d. Hazard Classification - A factory, Beacon Texile Printers Ltd., is located about 100 feet downstream of the dam, on the right side of the downstream channel. Loss of life in this factory is likely if the dam were to fail. Glenham dam is, therefore, considered in the "high" hazard category, as defined by the Recommended Guidelines for Safety Inspection of Dams.

e. Ownership - The dam is owned and operated by
    Beacon Texile Printers Ltd., Mill and Front Street,
    Beacon, New York 12508. The contact person is
    Lineo Fernandez (telephone 914-831-1300).

f. Purpose of Dam - Glenham Dam is used as the water
    source for Beacon Texile Printers Ltd.

g. Design and Construction History - The dam was
    originally built around 1875, but the original
    builders and designers are unknown. The dam was
    reconstructed in 1911-1915. These alterations
    were engineered by Fred D. Rhodes and Edward N.
    Friedman. The architects were Freedman, Robertson
    and Keeler of New York City, and the construction
    work was done by Murphy Bros. of New York City.

h. Normal Operating Procedures - The reservoir level
    is normally maintained near the crest of the
    spillway. However, according to Beacon Texile
    Printer's Chief of Maintenance, the reservoir
    level sometimes drops as much as 9 feet below the
    crest of the dam during dry summers. The dam is
    visually inspected each month. The three valves
    controlling the water flow to the factory are in
    good condition and are operated every three or
    four months, according to the Chief of Maintenance.
    The fourth valve, on the crest of the dam, controls
    the 4.5-foot diameter outlet pipe at the toe of
    the dam. This valve was partially opened at the
    time of inspection; it reportedly cannot be entirely
    closed, but it can be opened. There is no operat-
    ing schedule or maintenance program for this dam.

1.3 PERTINENT DATA

a. Drainage Area (square miles) -   188.57

b. Discharge at Dam (c.f.s.) -

    Spillway Capacity (at Minimum Top of
      Dam Elev. 169.6 ft. M.S.L.)^2 19,761.0
    Reservoir Drain at Normal Pool   342.0

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^{2}All elevations are referenced to the spillway crest, elev.
159.0 ft. M.S.L. estimated from the USGS 7.5 minute topo-
graphic quadrangle, Wappingers Falls, New York.

c. __Elevation (Feet Above M.S.L.)__ -

Minimum Top of Dam	169.6
Normal Pool (Spillway Crest)	159.0
Streambed at Toe of Dam	124.7

d. __Reservoir Surface (Acres)__ -

Top of Dam (Elev. 169.6 ft. M.S.L.)	1.90
Spillway Crest (Elev. 159.0 ft. M.S.L.)	1.45

e. __Reservoir Storage Capacity (Acre-Feet)__ -

Top of Dam (Elev. 169.6 ft. M.S.L.)	43.0
Spillway Crest (Elev. 159.0 ft. M.S.L.)	25.0

f. __Dam__ -

Type: Concrete gravity	
Length (Feet)	312.0
Height (Feet)	44.9
Top Width (Feet)	8.5 to 24.0
Side Slopes - Upstream	Vertical
Downstream	Vertical to 1H:1V

Cut-off: None - according to design plans, the dam is built on hardpan and rock.

g. __Spillway__ -

Type: Concrete ogee-shaped weir	
Crest Length Perpendicular to Flow (Feet)	140.0
Crest Width Parallel to Flow (Feet)	6.5
Crest Elevation (ft. M.S.L.)	159.0

h. __Reservoir Drain__

Type: A 4.5-foot diameter brick-lined conduit that extends from the upstream face to the toe of the dam.

Control: A gate valve operated from the crest of the dam is used to control flow through this pipe.

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SECTION 2: ENGINEERING DATA

2.1 GEOLOGY

Glenham Dam is located in the southeastern section of
the "Appalachian Uplands" physiographic province of New
York State. This province is geologically complex and
characteristically composed of a diverse group of
sedimentary metamorphic and igneous rocks which have
been tectonically disturbed by normal and thrust faulting.

Bedrock in the immediate vicinity of the dam is repre-
sented by sedimentary and metamorphic rocks of Ordovician,
Cambrian, and Precambrian age. The Ordovician rocks
are composed of the Mount Merino and Indian River
Formation, a shale; the Austin Glen Formation, a shale
and graywacke; the Walloonsac Formation, a phyllite
schist and metagraywacke; and the Balmville Limestone.
Cambrian exposures consist of the Poughuag Quartzite
and Precambrian exposures consist of a hornblende
gneiss. The Precambrian hornblende gneiss has been
thrust over the Ordivician Austin Glen and Indian River
Formations. To the southeast of the thrust fault, a
large normal fault has developed in the hornblende
gneiss. Between the thrust fault and normal fault, the
hornblende gneiss has been covered by a thin veneer of
Quatenary glacial till. Within the area defined by the
glacial till remnants of the Balmville Limestone and
Walloonsac Formation have been identified. The only
exposure of the Poughuag Quartzite is along the normal
fault within the hornblende gneiss, suggesting it is a
quartz vein filling which has formed along the fault
plain. Both faults occur within 2 miles of the lake.

2.2 SUBSURFACE INVESTIGATION

Detailed subsurface information was unavailable for
consideration as part of this investigation. A letter
dated 1 November 1911 states "the dam rests partly on
rock and partly on hard-pan." This, however, was
conjecture on the part of the writer, based on discussion
with two men who helped build the dam in 1875. A rock
outcrop located at the right abutment consisted of
hornblende granite to granitic gneiss. The left abutment
rock outcrop is a complex formation of quartzite and
limestone with overlying glacially derived soils. This
soil is identified in the soils report for Dutchess
County (prepared by the Soil Conservation Service) as
Troy gravelly loam. The soils on the right abutment
are man-made fills.

2.3 DAM AND APPURTENANT STRUCTURES

The original plans for this dam were unavailable. However, plans by Fred D. Rhodes and Edward N. Friedman showing the alterations made to the dam between 1911-15 when the dam was raised 7 feet were available for review and included in Appendix E.

The dam is used as a water supply for the adjacent factory. The dam is an "L"-shaped concrete gravity structure with a 140-foot wide ogee-shaped spillway with a vertical upstream face and a downstream face with a slope of 1H:1V (Horizontal to Vertical). The spillway discharges into a 65-foot long stilling basin with its left side being the rock from the left abutment; the right side is a concrete training wall. At the downstream end of the stilling basin, the water flows over a rounded concrete berm into the natural river channel. The right side of the dam, parallel to the flow, is a complex concrete structure 27 feet above the natural ground.

Three control valves are on the crest near the center of the right side of the dam. These three valves control the flow of water to the adjacent factory. A fourth control valve is located on the crest near the spillway to control the flow from the 5-foot diameter outlet pipe at the toe of the dam.

2.4 CONSTRUCTION RECORDS

No records are available for the original construction of the dam. A letter dated 1 November 1911 from Fred D. Rhodes, Consulting Engineer, to the State of New York Conservation Commission states that the dam is founded partly on rock and partly on hard-pan. The letter further explains the proposed steps to be followed during the raising of the dam. This letter is included in Appendix G. No other construction records were available for this investigation.

2.5 OPERATING RECORDS

No operating records are maintained by the owner. However, according to the Chief of Maintenance, the dam is visually inspected monthly, and the control valves are operated periodically.

2.6 EVALUATION OF DATA

The background information collected during this investigation was obtained primarily from files of the New York

State Department of Environmental Conservation. Supple-
mentary information was acquired through conversations
with Mr. Rino Furlani, Chief of Maintenance, Beacon
Textile Printers, Ltd. The available data are considered
adequate and reliable for Phase I Inspection purposes.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a.   General - The visual inspecton of Glenham Dam was
     conducted on 8 March 1981. The weather was cloudy
     with temperatures around 35° F. At the time of
     inspection, the reservoir level was at 180.0 feet
     M.S.L. Deficiencies found during the inspection
     will require remedial measures. A Field Sketch of
     conditions found during the inspection is included
     in Appendix E. The complete Visual Inspection
     Checklist is presented as Appendix B.

b.   Spillway - The spillway makes up the left side of
     the dam. It extends 140 feet from the left abutment
     across the river and connects to the right side of
     the dam which is perpendicular to the spillway
     crest. The spillway is an ogee-shaped concrete
     weir with a near-vertical upstream face, a rounded
     crest, and a downstream face with a slope of 45°.
     Approximately 1.0 foot of water was flowing over
     the crest at the time of inspection, making observa-
     tion difficult. There were no major cracks observed.
     The spillway is bound by a near-vertical stone
     face on the left side, and there appeared to be no
     major problem at the left side of the spillway.
     The right side of the spillway is bound by the
     vertical face of the right side of the dam. This
     face forms a concrete wall above the crest of the
     dam, and the portion of the wall above the downstream
     slope is made of brick and stone. The concrete
     above the crest is spalling, and the mortar has
     been washed away from some of the joints of the
     brick and stone wall above the downstream side of
     the spillway. Grass is growing in some of the
     joints near the downstream side of the spillway.

     The spillway discharges into a stilling basin
     which is 140 feet long and extends 65 feet beyond
     the toe of the dam. The water discharges over a
     1-foot wide and 3-foot high rounded concrete end
     sill. There appeared to be no major problems with
     the stilling basin; however, the water was 3.5
     feet deep at the time of inspection, making visual
     observation difficult.

c.   Dam - The right side of the dam is a concrete
     structure about 200 feet long with a height of
     44.9 feet. Due to the complex shape of this side,

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the crest width varies from 8.5 feet to 25 feet
(see Appendix E - Field Sketch). The dam is made
up of three different horizontal levels. The
first (and top) level of the dam is capped by a
deteriorated and spalled concrete surface. However,
the concrete near the valve controls appears to be
in good condition with no signs of spalling. At
two places on the dam, there is a second horizontal
level about 10 feet below the crest. This second
level varies in width from 7.5 feet to 18 feet.
This level is capped by rectangular-shaped pre-cut
stone slabs about 4 inches thick. The third and
lowest level of the dam is about 16 feet below the
second level. This level is located at the base
of the dam about 14 feet above the water level of
the stilling basin. The bottom level is capped by
pre-cut stone slabs. At the downstream end of the
dam, the second and third levels are connected by
a 45° sloping wall, also capped by pre-cut stone
slabs. Nearly all of the joints between these
stone slabs are overgrown with grass, weeds, brush
and a few small trees. The side of the dam toward
the reservoir is a vertical concrete surface that
has been entirely spalled. The outside of the dam
varied from a vertical to a 1H:5V (Horizontal to
Vertical) slope. The majority of this surface was
also spalled. In some places, the outer concrete
layer had completely deteriorated, revealing a
brick wall about 6 inches to 8 inches behind the
former concrete surface. There is a clinging vine
growing on the dam's concrete surface. This vine
covers about 50% of the concrete surface.

Six seeps are located near the base of the dam
(see Appendix E - Field Sketch). The seeps were
all flowing clear with no signs of turbidity at
the time of inspection. The estimated rate of
flow of these seeps varied between 0.5 and 1.0 gpm
(gallons per minute). A plywood box has been
built around one of these seeps. This box appar-
ently collects the water and discharges it through
a pipe to the toe of the dam.

d. <u>Outlet Works</u> - Four control valves are located on
the crest of the dam. Three control flows to the
factory and one controls a 4.5-foot diameter
outlet pipe. Two of these valves, the partially
opened valve for the 4.5-foot diameter outlet pipe
and the opened valve supplying water to the factory,
appeared to have been recently greased. According
to the Chief of Maintenance, all four valves are

operable with the exception of the valve on the main outlet pipe that cannot be entirely closed. The top part of the iron grating that makes up the trash rack over the three outlet pipes for the factory appeared to be in good condition.

It appeared that the outer 8-inch layer of concrete facing has washed away from the outlet area of the 5-foot diameter conduit, revealing a cut-stone wall. There was little or no mortar between the joints of these stones. Behind this stone wall was the brick-lined 5-foot diameter conduit. An I-beam was laying across the outlet of this conduit and could partially obstruct the conduit when the flow through the pipe reaches or exceeds a depth of 18 inches.

e. Downstream Channel - The downstream channel below the stilling basin is a natural river channel about 120 feet wide and lined by a cut-stone vertical river wall about 8 feet high on the right side and a natural slope on the left side. The outlet conduit discharges into a separate side channel about 15 feet wide that is bound by the cut-stone river wall on the right side and by a 2-foot thick concrete wall separating the channel from the stilling basin on the left side. This concrete wall ends about 100 feet below the outlet of the pipe where the side channel joins the natural river channel.

A factory, Beacon Texile Printers Ltd., is located about 100 feet downstream of the dam on the right side of the downstream channel and just above the river wall.

f. Reservoir - The slopes adjacent to the reservoir, are mostly bare rock outcroppings. There were no signs of instability, and sedimentation was not reported to be a problem.

3.2 EVALUATION

The visual inspection revealed several deficiencies in this structure. The following items were noted:

1. Six seeps (from approximately 0.5 to 1.0 gpm) are located near the base of the dam.

2. The right spillway training wall has some of the mortar washed out from between the bricks.

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3. On the downstream side of the right wall, the concrete has deteriorated to show the brick core.

4. The concrete facing has washed away from the outlet area of the 5-foot diameter conduit.

5. An I-beam is laying across the outlet end of the 5-foot diameter outlet pipe.

6. The 5-foot diameter outlet pipe valve cannot be entirely closed.

7. The crest on the right side of the dam has a spalled and deteriorated surface.

8. Almost all of the dam's concrete surface is spalled and deteriorated.

9. Trees and grass are growing in the joints of the cut stones on the crest of the dam.

10. A clinging vine covers 50 percent of the concrete surface.

SECTION 4: OPERATION AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

There are no formal written instructions for operating
the reservoir. The normal water surface elevation is
near the spillway crest elevation of 159.0 feet M.S.L.
Water can be released to the downstream area through a
5-foot diameter brick-lined conduit; however, the valve
controlling this conduit, operated from the crest of
the dam, cannot be entirely closed. There are three
other valves on the crest of the dam that control the
water flow to the Beacon Texile Printers Ltd. factory.

4.2 MAINTENACE OF DAM

Maintenance of the dam is the responsibility of Beacon
Textile Printers, Ltd. The maintenance of the dam is
considered inadequate, as evidenced by the general
deterioration of the dam. The Chief of Maintenance
inspects the dam about every month. The three valves
that control the flow of water to the factory are
operated every three or four months.

4.3 WARNING SYSTEM

At the time of the inspection, there was no warning
system or emergency action plan in operation.

4.4 EVALUATION

Past maintenance of the dam and operating facilities
appears to have been inadequate. A checklist should be
compiled by the owner's representative to document the
findings made during the periodic inspections and the
maintenance items completed. A warning system and
emergency action plan should be developed and put into
operation.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

The drainage area consists of gentle-to-moderate slopes well covered by forests and ground vegetation. Some upland storage exists in the form of flat and swampy areas and small lakes. The total drainage area is 188.57 square miles.

5.2 ANALYSIS CRITERIA

The hydraulic capacity of the dam, reservoir, and spillway was assessed by utilizing the U.S. Army Corps of Engineers Flood Hydrograph Package HEC-1 DB. The hydrologic characteristics of the basin, specifically the Snyder's Unit Hydrograph Parameters, were average values derived from the Hydrologic Flood Routing Model for Lower Hudson River Basin, Fishkill Creek (Reference 14, Appendix D). The runoff hydrograph was developed by simulating the Standard Project Storm (SPS). Total SPS rainfall and excess were used to approximate the SPS flow at the USGS gage number 3735 at Beacon, New York of 26,207 c.f.s. This gage is 1300 feet downstream from Glenham Dam. Using tp = 10.0 hr., Cp = 0.44, initial rainfall loss of 3.5 in., and a constant loss rate of 0.45 in./hr., a flow of 28,535 c.f.s. was obtained. This flow is 8 percent of that calculated in Hydrologic Flood Routing Model for Lower Hudson River Basin, Fishkill Creek for this gage. The PMP rainfall amounts were then substituted for the SPS amounts. The PMF and 1/2 PMF were then routed through the reservoir and dam.

5.3 SPILLWAY CAPACITY

The spillway capacity at the minimum top of dam is 19,761 c.f.s. There is no auxiliary or emergency spillway.

5.4 RESERVOIR CAPACITY

The storage capacity of Glenham Dam at normal pool is 25 acre-feet. The storage capacity of the reservoir at the minimum top of dam is 43 acre-feet. Therefore, the flood control storage of the reservoir between the spillway crest and the top of the dam is 18 acre-feet. This volume represents a total runoff of 0.002 inches from the drainage area.

15

5.5 FLOOD OF RECORD

The maximum flow at the USGS gage 1300 feet downstream was 19,737 c.f.s. during Agnes in 1972; this should have just come to the top of the dam. The person contacted at the dam had only been associated with the dam for a short time and had no knowledge of the depth of flow over the spillway during this flood event.

5.6 OVERTOPPING POTENTIAL

The maximum capacity of the spillway is 19,761 c.f.s. at the minimum top of dam. The peak outflows of the PMF and 1/2 PMF are 60,570 c.f.s. and 30,287 c.f.s., respectively. Therefore, the spillway is capable of passing 33 percent of the PMF before overtopping would occur.

5.7 RESERVOIR EMPTYING POTENTIAL

The reservoir can be drawn down by means of a 4.5-foot diameter brick conduit at the toe of the dam. Neglecting inflow, the reservoir can be drawn down from normal pool in approximately one hour. This is equivalent to an approximate drawdown rate of 25 feet per hour, based on the hydraulic height measured from normal pool divided by the time to dewater the reservoir.

5.8 EVALUATION

Glenham Dam is an "intermediate" size - "high" hazard dam requiring the spillway to pass a flood in the range of PMF. The PMF and 1/2 PMF were routed through the watershed and dam. It was determined that the spillway is capable of passing 33 percent of the PMF before overtopping the dam. Structural stability analysis based on available information, indicate that factors of safety against overturning are less than desirable. When the dam is subjected to severe loading conditions such as a 1/2 PMF or PMF event, the factors of safety fall below the stable levels. The spillway is, therefore, judged to be "seriously inadequate."

Conclusions pertain to present conditions and the effect of future development on the hydrology has not been considered.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations - No signs of instability were noted during the field inspection. Problems observed which could affect the stability of the structure include:

1. Numerous seeps through the brickwork of the dam.

2. Several locations where the mortar has disintegrated and washed out from the brickwork.

3. Severe degradation of the concrete surfaces of the dam.

4. Several places where the concrete facing has fallen off of the dam exposing the brickwork.

As a result of the visual inspection of these items, it is recommended that an in-depth study of the seepage and its effect on the brickwork and stability of the dam be performed. This in-depth study should result in the implementation of appropriate remedial measures.

b. Design and Construction Data - No design information regarding the stability of the structure was available.

c. Operating Records - No operating records were available for review.

d. Post Construction Changes - The structure was raised 7 feet in 1914. At that time, a cutoff; discharge basin; and other dam improvements were performed. Newspaper articles attached in Appendix G are the only available information source concerning these improvements.

6.2 STABILITY ANALYSIS

The results of any previous stability analyses were unavailable for reference during this evaluation. A section at the overflow was selected for analysis because it appeared to represent the most critical section. The cases analyzed and respective results are as follows:

Case	Description of Loading Conditions
1	Normal operating conditions with reservoir level at the spillway crest, full uplift, and tailwater corresponding to the tailwater sill elevation 128.1 ft. M.S.L.
2	Same as Case 1 with the addition of ice loading of 5000 pounds per lineal foot.
3	Reservoir level during the 1/2 PMF, full uplift, tailwater elevation of 142.0 ft. M.S.L.
4	Reservoir level during the PMF, full uplift, tailwater elevation of 147.2 ft. M.S.L.

| | Factor of Safety | | Location of Resultant |
Case	Overturning	Sliding	from Toe (ft.)
1	1.45	4.78	18.00
2	1.37	4.21	15.78
3	0.91	2.58	-13.22
4	0.84	2.34	-38.25

Notes: Location of middle 1/3 is 40 to 20 feet from the downstream toe.

A negative (-) above indicates that the location of the resultant is downstream from the toe.

A value of 2 ksf was used as a conservative approximation of the shear strength of weathered rock.

In all cases, the factors of safety against overturning are generally low, and the locations of the resultants fall outside of the middle 1/3. Therefore, the dam is considered unsafe against overturning. The factor of safety against sliding was less than the recommended value of 3 for Cases 3 and 4. However, the structure has withstood normal loading conditions in the past without apparent damage, and the analyses may not indicate the true field conditions or proper loading conditions. Since overturning or sliding would result in a probable loss of life downstream of the dam, a detailed stability analysis of the dam should be performed by a qualified engineering firm within three months of owner notification.

6.3 SEISMIC STABILITY

Glenham Dam is located in Seismic Zone 1 which presents
no hazard from earthquakes according to the Recommended
Guidelines for Safety Inspection of Dams by the Depart-
ment of the Army, Office of the Chief of Engineers.
This determination is contingent on the requirements
that static stability conditions are satisfactory, and
conventional safety margins exist. As reported in
Paragraph 6.2, the dam has low factors of safety against
overturning and sliding. If the requested additional
analysis does not indicate conventional safety margins
against overturning and sliding, additional analysis of
the effects of earthquakes on the structural stability
must be performed.

SECTION 7: ASSESSMENT/RECOMMENDATIONS

7.1 ASSESSMENT

a. Safety - Examination of available documents and
    visual inspections of Glenham Dam did not reveal
    any conditions which constitute an immediate
    hazard to human life or property.

    Using the Corps of Engineers' screening criteria
    for review of spillway adequacy, it has been
    determined that the dam would be overtopped for
    all storms exceeding approximately 33 percent of
    the PMF. The overtopping of the dam could result
    in dam failure, increasing the hazard to loss of
    life downstream. Therefore, the spillway is
    adjudged as "seriously inadequate," and the dam is
    assessed as "unsafe, non-emergency."

    The stability analyses of the dam performed for
    this investigation indicate that the factors of
    safety against overturning and sliding may be
    inadequate. In addition, an in-depth study of the
    seepage and affect of the seepage on the brickwork
    of the dam must be performed.

b. Adequacy of Information - All evaluations and
    assessments in this report were based on field
    observations, conversations with the owner's
    representative, available engineering data, and
    office analyses. The information collected is
    considered adequate for a Phase I Inspection.

c. Need for Additional Investigation - Detailed
    hydrologic and hydraulic investigations of the
    structure are considered necessary to more accurately
    determine the overtopping potential of the dam and
    to determine mitigating measures in response to
    the spillway inadequacy. A detailed stability
    analysis of the dam is considered necessary to
    determine actual stability conditions. An in-
    depth study of the seepage and effect on the
    brickwork must be performed.

d. Urgency - The detailed hydrologic and hydraulic
    investigations and stability analyses must be
    initiated within three months of owner notification.
    The in-depth study of the seepage and effect on
    the brickwork must also be initiated within three
    months. Within one year, remedial measures result-
    ing from these investigations must be initiated,

with their completion during the following year. In the interim, a detailed emergency action plan must be developed and implemented during periods of unusually heavy precipitation. Around-the-clock surveillance must also be provided during these periods. The problem areas listed in Section 7.2 must be corrected within one year of notification.

7.2 RECOMMENDED MEASURES

The regular inspections and maintenance procedures presently being conducted appear to be inadequate. A thorough checklist should be compiled by the owner's representative and completed during each inspection. Maintenance items should be completed annually. Monitoring of the reservoir level should be expanded to include reservoir levels above normal pool.

Monitor the seeps in the dam at regular intervals and during periods of high reservoir levels for turbidity and increase in flow.

The following remedial measures must be completed within one year:

1. Point the joints between bricks on the right spillway training wall.

2. Repair the deteriorated concrete on the downstream side of the right wall of the dam.

3. Replace the concrete facing around the 4.5-foot diameter outlet conduit.

4. Repair the outlet pipe valve.

5. Repair the spalled and deteriorated concrete surface on the crest on the right side of the dam.

6. Repair all spalled areas on the concrete surfaces of the dam.

7. Remove all vegetation from the dam.

APPENDIX A

PHOTOGRAPHS

CONTENTS

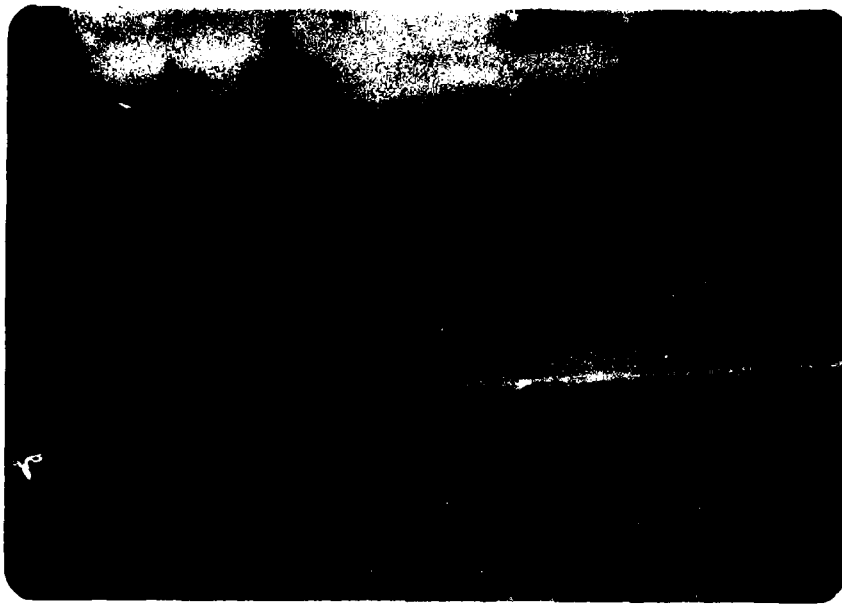Note: Photographs were taken on 8 March 1981.

Photo 1.   View Looking Upstream at Right Half of Spillway
8 March 1981

Photo 2.   View Looking Upstream at Left Half of Spillway
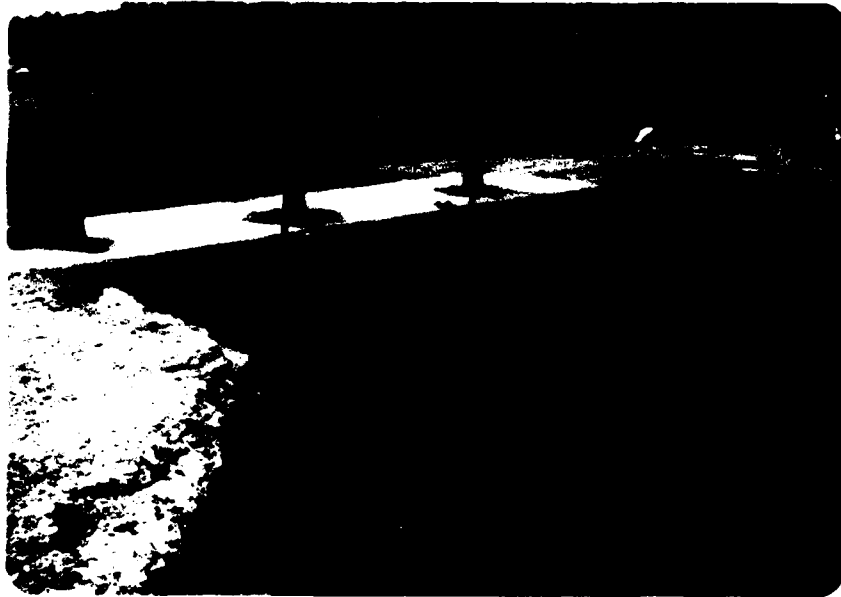8 March 1981

GLENHAM DAM

Photo 3. Upstream View of Water Intake Structure
8 March 1981

Photo 4. Upstream View of Outlet Gate Stem and Valve
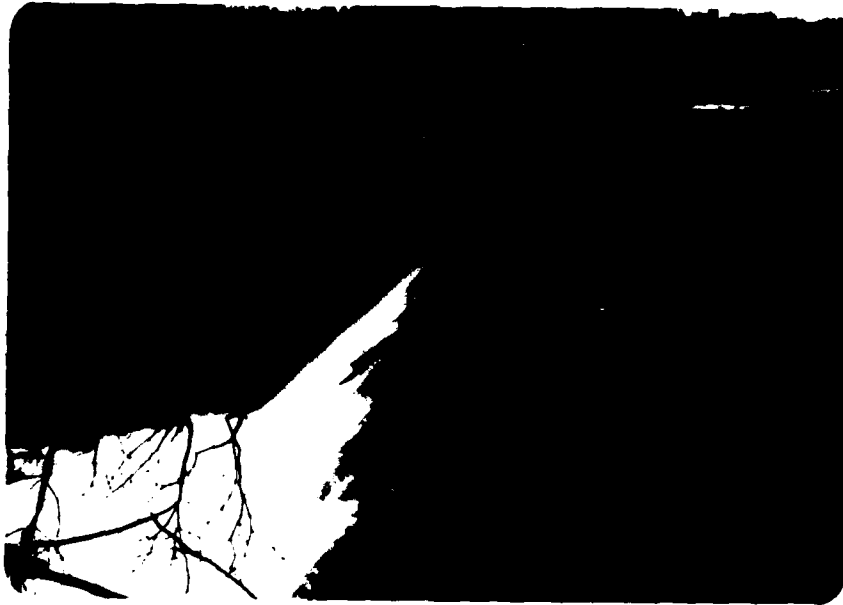8 March 1981

Photo 5. View Across Crest of Spillway From Left Abutment
8 March 1981

Photo 6. View of Downstream Headwall of Outlet and
Discharge Channel From Plant
8 March 1981

Photo 7. Close-Up View of Downstream Outlet Headwall
8 March 1981

Photo 8. View Looking Upstream Inside Outlet Tunnel
8 March 1981

Photo 9.   View of Right Downstream Face of Dam
8 March 1981

Photo 10.   View of Right Downstream Face of Dam
8 March 1981

Photo 11.   View of Right Downstream Face of Dam
8 March 1981

Photo 12.   View Looking Upstream at Right Downstream Face of Dam
8 March 1981

Photo 13. View of Seepage Through Dam
(See Photo 11 for Location of Red Bucket)
8 March 1981

Photo 14. View of Old Weir Box for Measurement of Seepage Through Dam
(Location Can Be Seen on Photo 10 Where the Left Side
Mirror of Vehicle is Located)
8 March 1981

APPENDIX B

VISUAL INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST

1) **Basic Data**

   a. **General**

   Name of Dam __Glenham Dam__

   Fed. I.D. # __NY 00072__   DEC Dam No. __212C-553__

   River Basin __Lower Hudson__

   Location: Town __Beacon__   County __Dutchess__

   Stream Name __Fishkill Creek__

   Tributary of __Hudson River__

   Latitude (N) __41° 30.8'__   Longitude (W) __73° 56.7'__

   Type of Dam __Masonry gravity dam__

   Hazard Category __High__

   Date(s) of Inspection __8 March 1981__

   Weather Conditions __Cloudy, 38° F.__

   Reservoir Level at Time of Inspection __180.0 ft.__

   b. **Inspection Personnel** __James G. Ulinski, Anthony P. Klimek and Steve__

   __Lockington__

   c. **Persons Contacted (Including Address & Phone No.)** __(914) 831-1300__

   __Rino Furlani - Chief of Maintenance__

   __Beacon Texile Printers, Ltd.__

   __Mill and Front Street__

   __Beacon, NY   12508__

   d. **History:**

   Date Constructed __1875__   Date(s) Reconstructed __1911-1915__

   Designer __Original unknown__

   Constructed By __Original unknown__

   Owner __Original unknown__

   Designer (1911-1915): Fred D. Rhodes and Edward N. Friedman
   Architects: Freedman, Robertson and Keeler
   Constructed By: Murphy Brothers of New York City
   Owner: Glenham Embroidery Company

2) **Embankment** - Not Applicable

    a.   Characteristics

        (1) Embankment Material _____

        _____

        (2) Cutoff Type _____

        _____

        (3) Impervious Core _____

        _____

        (4) Internal Drainage System _____

        _____

        (5) Miscellaneous _____

        _____

    b.   Crest

        (1) Vertical Alignment _____

        _____

        (2) Horizontal Alignment _____

        _____

        (3) Surface Cracks _____

        _____

        (4) Miscellaneous _____

        _____

    c.   Upstream Slope

        (1) Slope (Estimate) (V:H) _____

        _____

        (2) Undesirable Growth or Debris, Animal Burrows _____

        _____

(3) Sloughing, Subsidence, or Depressions _____

_____

_____

(4) Slope Protection _____

_____

_____

(5) Surface Cracks or Movement at Toe _____

_____

d. Downstream Slope

(1) Slope (Estimate - V:H) _____

_____

(2) Undesirable Growth or Debris, Animal Burrows _____

_____

_____

(3) Sloughing, Subsidence or Depressions _____

_____

_____

(4) Surface Cracks or Movement at Toe _____

_____

(5) Seepage _____

_____

_____

(6) External Drainage System (Ditches, Trenches, Blanket) _____

_____

_____

(7) Condition Around Outlet Structure _____

_____

(8)   Seepage Beyond Toe _____

_____

_____

e.   Abutments - Embankment Contact _____

_____

(1)   Erosion at Contact _____

_____

_____

(2)   Seepage Along Contact _____

_____

_____

3)   Drainage System

a.   Description of System ___None observed_____

_____

b.   Condition of System ___Not applicable_____

_____

c.   Discharge from Drainage System _Not applicable_____

_____

_____

4)   Instrumentation (Monumentation/Surveys, Observation Wells, Weirs,
Piezometers, Etc.) __None_____

_____

_____

_____

_____

5) Reservoir

    a.   Slopes   The slopes immediately adjacent to the reservoir are steep rock outcroppings.

    b.   Sedimentation   Sedimentation was not directly observed, however, it is not reported to be a significant problem.

    c.   Unusual Conditions Which Affect Dam   None observed.

6) Area Downstream of Dam

    a.   Downstream Hazard (No. of Homes, Highways, etc.)   A factory, Beacon Textile Printers, Ltd., is located about 100 feet downstream of the dam. Loss of life in this factory is likely if the dam were to fail.

    b.   Seepage, Unusual Growth   Clear water was flowing out of the rock on the left abutment at about 5 to 10 gpm (gallons per minute) about 30 ft. below the spillway.

    c.   Evidence of Movement Beyond Toe of Dam   None observed.

    d.   Condition of Downstream Channel   The downstream channel is bound by a steep rock face on the left side and a cutstone vertical river wall, about 7 ft. high, on the right side.

7) Spillway(s) (Including Discharge Conveyance Channel)

a. General <u>The spillway consists of a rounded concrete ogee-shaped weir 140 ft.</u>
<u>wide (measured perpendicular to the flow) and has a rounded crest approxi-</u>
<u>mately 6 ft. wide. The upstream face of the spillway is vertical for about</u>
<u>10 ft. below the crest, then slopes to the bottom of the reservoir at about</u>
<u>a 1H:1V slope. The downstream face of the spillway has a slope of about 1H:1V</u>
<u>across its entire width. The spillway is bound by the 11-ft. high vertical</u>
<u>concrete face of the dam on the right side and two nearly vertical rock out-</u>
<u>croppings on the left side. The right side of the downstream spillway face is</u>
<u>bound by a stone and brick wall.</u>

b. Condition of Service Spillway <u>There was a foot of water going over the crest</u>
<u>of the spillway at the time of inspection, making observation difficult.</u>
<u>There were no major cracks observed in the spillway, and it appeared to be</u>
<u>in fair condition. The concrete on the right training wall was badly spalled,</u>
<u>and mortar was missing from some of the joints in the stone on the right</u>
<u>training wall.</u>

c. Condition of Auxiliary Spillway <u>None</u>

d. Condition of Discharge Conveyance Channel <u>The spillway discharges into a</u>
<u>stilling basin 65 ft. long and 140 ft. wide. This basin is bound by</u>
<u>a vertical rock outcropping on the left side and a 2-ft. wide concrete</u>
<u>wall on the right side. The basin discharges into the natural river by</u>
<u>dropping over a 3-ft. high by 1-ft. wide rounded, concrete end sill extending</u>
<u>across the downstream end of the stream basin.</u>

8) <u>Reservoir Drain/Outlet</u>

Type: Pipe _____ Conduit ____X____ Other _____

Material: Concrete _____ Metal . _____ Other <u>Bricklined</u>

Size: <u>4.5 ft. dia.</u> _____ Length <u>84 ft. (estimated from plans)</u>

Invert Elevations: <u>Entrance 129.7 (estimated)</u> Exit <u>128.7</u> .

Physical Condition (Describe): Unobservable ___X_____

Material: __Bricklined conduit__

Joints: __Unobservable__   Alignment __According to the plans, there are two 45° bends in the pipe__

Structural Integrity: __Unobservable__

Hydraulic Capability: __No problems observed.__

Means of Control: Gate _____ Valve __X__ Uncontrolled _____

  Operation: Operable _____ Inoperable _____ Other __X__

  Present Condition (Describe): __Water was flowing through the conduit__ __at the time of inspection. According to the chief of maintenance, the__ __valve can be opened, but it cannot be entirely closed; therefore, water__ __always flows through the conduit.__

9) __Structural__

  a. Concrete Surfaces __Nearly every concrete surface on the dam was badly spalled__ __and deteriorated. In some places, the concrete had eroded as much as 6 in.__ __There were some small trees, grass and vines growing on some of the surfaces.__ __The concrete around the valve controls was in good shape and without signs__ __of spalling. In some places, the eroded concrete exposed a brick wall__ __about 8 in. behind the concrete surface.__

  b. Structural Cracking __None observed__

  c. Movement – Horizontal & Vertical Alignment (Settlement) __None observed__

  d. Junctions with Abutments or Embankments __The right side of the dam joins__ __the right abutment at a rock outcropping. There were no problems observed__ __at this junction. The left side of the spillway joins the left abutment__ __at a vertical rock face. The left junction was under water and could not__

be observed at the time of inspection. No information was available about possible keying into the abutments.

e. Drains - Foundation, Joint, Face None observed.

f. Water Passages, Conduits, Sluices There are four valves that control the water flow through the dam. One valve controls the 5-foot diameter outlet pipe for the dam; this valve was partially opened at the time of inspection. The three other valves are located beside one another and control the flow through pipes that go into Beacon Textile Printers, Ltd. One valve was completely opened and supplying water to the factory at the time of inspection. According to the Chief of Maintenance, with the exception of the valve that controls the outlet and cannot be completely closed, the valves are in working condition and are operated every three or four months.

g. Seepage or Leakage There were six seperate seeps observed near the dam base. They were all flowing clear with no signs of turbidity and varied between 0.5 and 10 gpm in estimated rate of flow.

h. Joints - Construction, etc. In places, the spalled concrete has revealed the brick wall, and water is seeping through the joints of the brick where the morter has been washed out. There is grass growing in the joints between the stone facing. There appears to be no problem in the joints between badly spalled concrete and the good concrete located around the valves.

i. Foundation According to design plans, the dam is built on a surface of rock and hard pan.

j. Abutments No problems observed.

k. Control Gates None

l.   Approach & Outlet Channels There is no approach or outlet channel for
     the spillway.

m.   Energy Dissipators (Plunge Pool, etc.) The spillway discharges into a
     stilling basin extending across the spillway width (140 ft.) and is 65
     ft. long. This basin is bound by a vertical rock outcropping on the left
     side and a 2-foot wide concrete wall on the right side. The basin dis-
     charges into the natural river by flowing over a 3-foot high by 1-foot wide
     end sill extending across the basin width.

n.   Intake Structures The inlets were under water and unobservable at the
     time of inspection. However, iron grating, utilized as a trash rack, was
     observed over the inlet areas to the three valves controlling the water
     flow to the factory.

o.   Stability No signs of instability were noted during the visual inspection.

p.   Miscellaneous The right side of the dam is perpendicular to the spillway
     crest. The dam is "L"-shaped.

10) Appurtenant Structures (Power House, Lock, Gatehouse, Other)

a.   Description and Condition None

APPENDIX C

HYDROLOGIC/HYDRAULIC DATA AND COMPUTATIONS

CHECK LIST FOR DAMS
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

AREA-CAPACITY DATA:

		Elevation (ft.)	Surface Area (acres)	Storage Capacity (acre-ft.)
1)	Top of Dam	169.6	1.90	43
2)	Design High Water (Max. Design Pool)	-----	----	--
3)	Auxiliary Spillway Crest	-----	----	--
4)	Pool Level with Flashboards	-----	----	--
5)	Service Spillway Crest	159.0	1.45	25

DISCHARGES

		Volume (cfs)
1)	Average Daily	279
2)	Spillway @ Maximum High Water - Top of Dam -	19,761
3)	Spillway @ Design High Water	---
4)	Spillway @ Auxiliary Spillway Crest Elevation	---
5)	Low Level Outlet	406
6)	Total (of all facilities) @ Maximum High Water	20,167
7)	Maximum Known Flood	Unknown
8)	At Time of Inspection	450

CREST: ELEVATION: ___169.6 ft.___

    Type: ___Concrete___

    Width: ___8.5 ft. to 24 ft.___   Length: ___312 ft.___

    Spillover ___

    Location ___Near left abutment___

SPILLWAY:

SERVICE		AUXILIARY
159.00 Ft.	Elevation	None
	Type	
6.5 ft.	Width	
	Type of Control	
X	Uncontrolled	
	Controlled:	
---	Type	
	(Flashboards; gate)	
---	Number	
---	Size/Length	
	Invert Material	
	Anticipated Length of Operating Service	
---	Chute Length	
10 ft.	Height Between Spillway Crest & Approach Channel Invert (Weir Flow)	

HYDROMETEROLOGICAL GAGES:

Type: None _____

Location: _____

Records:

    Date:_____

    Max. Reading:_____

FLOOD WATER CONTROL SYSTEM:

Warning System: None _____

_____

Method of Controlled Releases (mechanisms):

Three valves on the crest control water to the adjacent factory, and one

valve controls the 4.5 ft. diameter conduit that outlets at the toe of the

dam. _____

DRAINAGE AREA: ___188.57 sq. mi.___

DRAINAGE BASIN RUNOFF CHARACTERISTICS:

    Land Use - Type: ___Mostly rural___

    Terrain - Relief: ___Gently sloping___

    Surface - Soil: ___Well drained___

    Runoff Potential (existing or planned extensive alterations to existing surface or subsurface conditions)

        . No known plans for altering the existing runoff patterns.

    Potential Sedimentation problem areas (natural or man-made; present or future)

        None observed ·

    Potential Backwater problem areas for levels at maximum storage capacity including surcharge storage:

        None observed

    Dikes - Floodwalls (overflow & non-overflow) - Low reaches along the Reservoir perimeter:

        Location: ___None___

        Elevation: _____

    Reservoir:

        Length @ Maximum Pool ___1100 ft.___

        Length of Shoreline (@ Spillway Crest) ___2300 ft.___

TOP OF DAM PROFILE (LOOKING DOWNSTREAM)
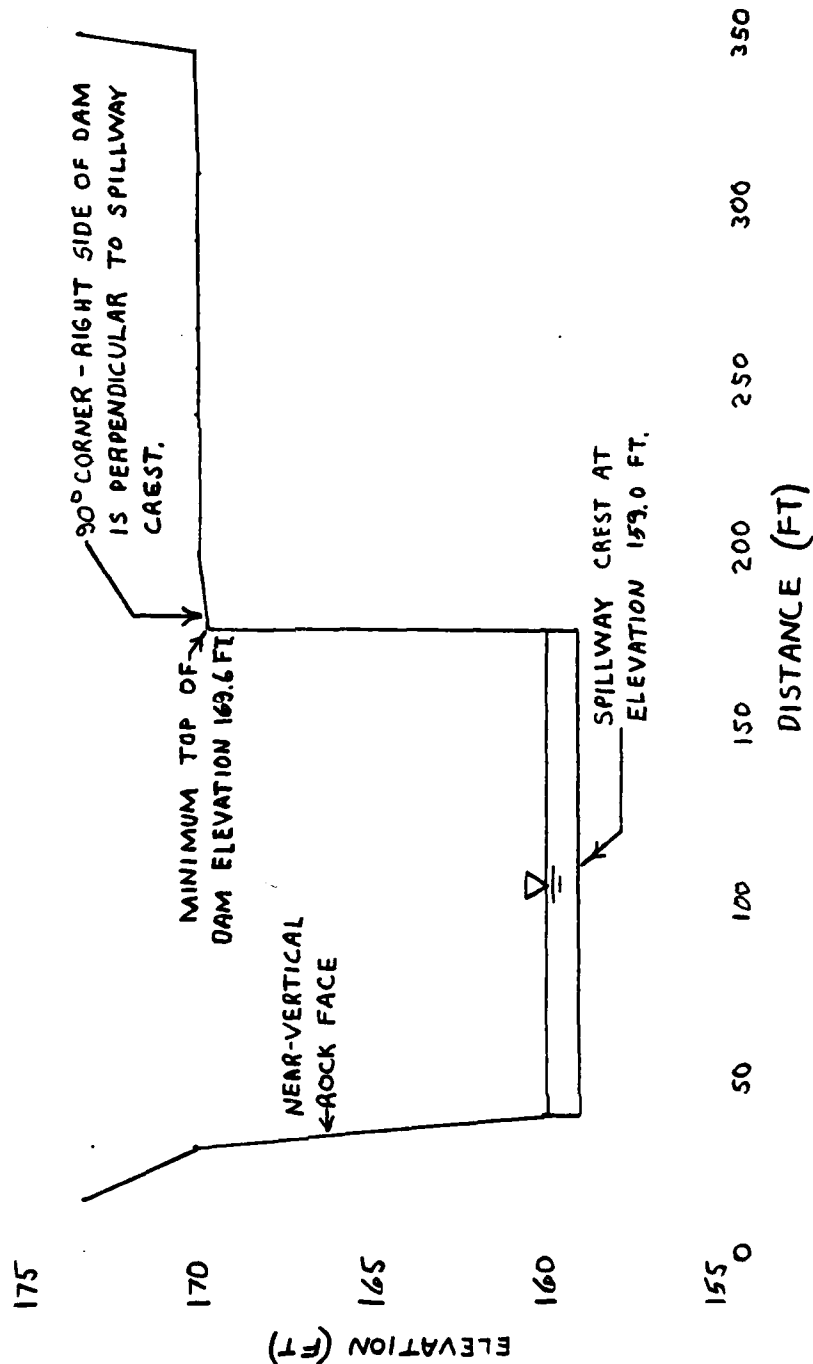
90° CORNER - RIGHT SIDE OF DAM IS PERPENDICULAR TO SPILLWAY CREST.

MINIMUM TOP OF DAM ELEVATION 169.6 FT.

NEAR-VERTICAL ROCK FACE

SPILLWAY CREST AT ELEVATION 159.0 FT.

ELEVATION (FT)

175

170

165

160

155

DISTANCE (FT)

0   50   100   150   200   250   300   350

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject __GLENHAM DAM__   S.O. No. _____
__CROSS SECTIONS OF DAM__   Sheet No. __6__ of __24__

Drawing No. _____
Computed by __APK__   Checked by __⫯__   Date __3-12-81__

CROSS-SECTION AT STATION 1+82
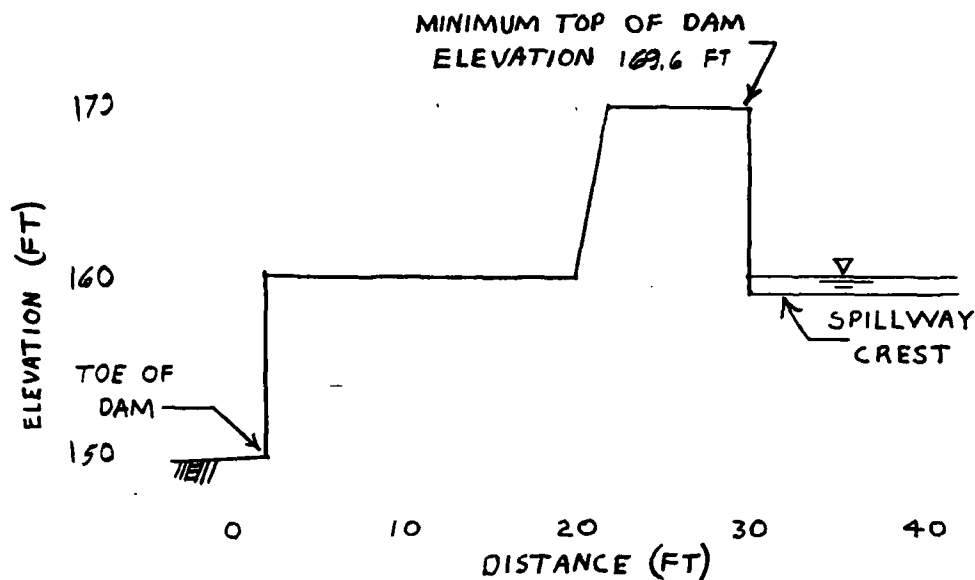
MINIMUM TOP OF DAM
ELEVATION 169.6 FT

170

160

SPILLWAY
CREST

TOE OF
DAM

150

ELEVATION (FT)

0   10   20   30   40
DISTANCE (FT)

CROSS SECTION AT STATION 2+57

CREST OF DAM
ELEVATION 169.9 FT.

170

160

WATER SURFACE
ELEVATION 160.0 F

TOE OF DAM
ELEVATION 152.6 FT

150

ELEVATION (FT)

0   10   20   30   40
DISTANCE (FT)
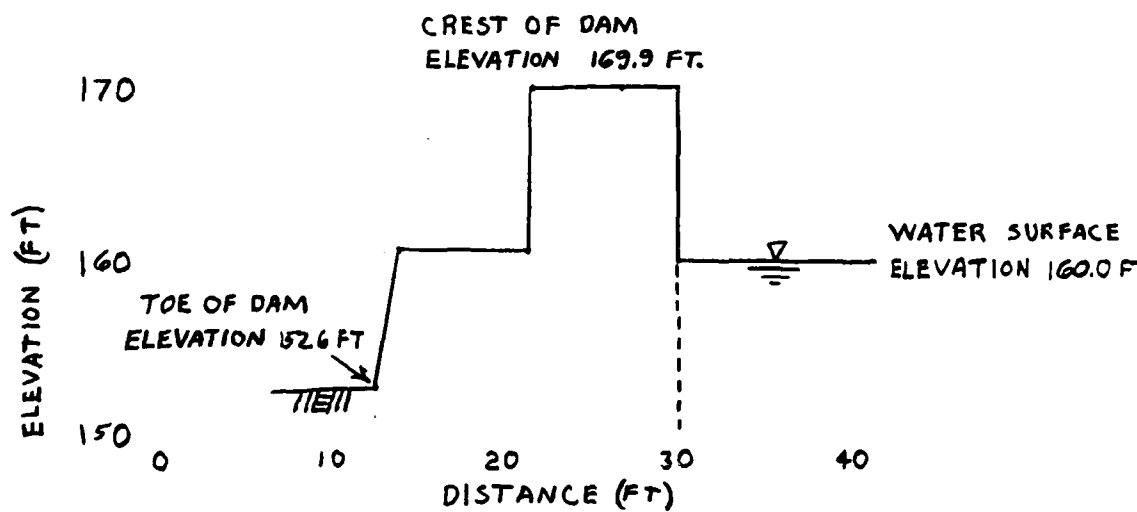
MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject __GLENHAM DAM__
__SPILLWAY PROFILE__

Computed by __APK__   Checked by __✦__

S.O. No. _____
Sheet No. _7_ of _24_
Drawing No. _____
Date __3-20-81__

TOP OF TRAINING WALL - (TOP OF DAM) ELEVATION 169.6 FT. M.S.L.

SPILLWAY CREST - ELEVATION 159.0 FT M.S.L.

CREST OF BERM AT STILLING BASIN OUTLET ELEVATION 128.1 FT. M.S.L.

STREAMBED OF STILLING BASIN - 124.7 FT. M.S.L.

ELEVATION (FT)

DISTANCE (FT)

MICHAEL BAKER, JR., INC.

THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAN DAM_
SPILLWAY RATING

Computed by __GWT__   Checked by __WDC__

S.O. No. _____

Sheet No. __8__ of __24__

Drawing No. _____

Date __5/27/81__

SPILLWAY PROFILE

SPILLWAY IS CONCRETE, ROUNDED WEIR WITH VERTICAL UPSTREAM FACE.

THE GENERALIZED DESIGN CURVES FOR SHAPING OGEE-WEIRS IN _DESIGN OF SMALL DAMS_, U.S. DEPT. OF THE INTERIOR, BUREAU OF RECLAMATION, WERE USED TO DETERMINE THAT THE DESIGN HEAD FOR THIS WEIR IS APPROXIMATELY 5.0 FEET.

$(H_0 = 5.0 \text{ FT})$

$$\frac{APPROACH \ DEPTH}{H_0} = \frac{10.0}{5.0} = 2.0$$

USING FIG. 249 IN DESIGN OF SMALL DAMS:
FOR $\frac{P}{H_0} = 2.0$, C_0 FOR A VERTICAL-FACED WEIR IS 3.94

WEIR FLOW
$q = C L H^{3/2}$

ELEVATION (FT)	C	H	q (CFS)
159.0	3.1	0	0
160.0	3.34	1	467.6
161.0	3.55	2	1405.7
162.0	3.70	3	2691.6
163.0	3.82	4	4278.4
165.0	4.01	6	8250.9
167.0	4.04	8	12,798.1
169.0	4.08	10	18,062.9
169.6	4.09	10.6	19,761.1
171.0	4.12	12	23,977.1
175.0	4.19	16	37,542.4
179.0	4.25	20	53,218.4
183.0	4.33	24	71,274.3

L = 140 FT.
H VARIES FROM 0 TO 24 FEET
C VARIES WITH H, FROM FIG. 250 IN "DESIGN OF SMALL DAMS"

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAM DAM_
OUTLET PIPE RATING

S.O. No. _____
Sheet No. _9_ of _24_
Drawing No. _____
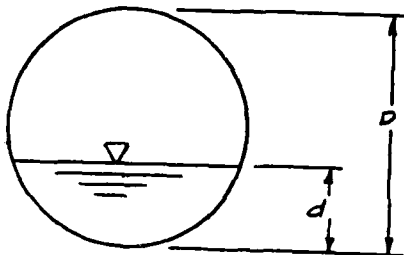Computed by _GWT_   Checked by _LAD_ Date _5/1/81_

INLET ELEV. - 129.7 FT. (ASSUMED) ✓

OUTLET ELEV. - 128.7 FT. ✓

LENGTH - 84 FEET ✓

4.5 FOOT BRICK LINED CONDUIT I.D. ✓
$n = 0.017$

"DESIGN OF SMALL DAMS" PAGES 558 AND 559

$D =$ DIA. PIPE
$d =$ DEPTH OF WATER
$S =$ PIPE SLOPE

$$= \frac{129.7 - 128.7}{84} = .0119 \checkmark$$

ELEVATION 132.0 FT.

$$\frac{d}{D} = \frac{2.25}{4.5} = .5 \quad \text{TABLE B-2} \quad 1.3955 = \frac{Q_c}{D^{5/2}} = \frac{Q}{4.5^{5/2}} \qquad Q = 59.9 \text{ C.F.S.} \checkmark$$

$$\frac{d}{D} = \frac{2.25}{4.5} = .5 \quad \text{TABLE B-3} \quad .232 = \frac{Qn}{D^{8/3} S^{1/2}} = \frac{Q(0.017)}{4.5^{8/3}(.0119)^{1/2}} \quad Q = 82.2 \text{ CFS} \checkmark$$

ELEVATION 133.0

$$\frac{d}{D} = \frac{3.4}{4.5} = .75 \quad \text{TABLE B-2} \quad 3.0607 = \frac{Q_c}{D^{5/2}} = \frac{Q}{(4.5)^{5/2}} \qquad Q = 131.5 \text{ C.F.S.} \checkmark$$

$$\frac{d}{D} = \frac{3.4}{4.5} = .75 \quad \text{TABLE B-3} \quad .422 = \frac{Qn}{D^{8/3} S^{1/2}} = \frac{Q(.017)}{(4.5)^{8/3}(.0119)^{1/2}} \quad Q = 149.5 \text{ C.F.S.} \checkmark$$

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAM DAM_
OUTLET PIPE RATING

S.O. No. _____
Sheet No. _10_ of _21_
Drawing No. _____
Computed by _GWT_ Checked by _LAD_ Date _5/1/81_

ORIFICE FLOW

$$Q = CA (2gH)^{.5}$$
$$Q = 77.83 \, H^{.5}$$

$A = \pi R^2 = \pi \left(\frac{4.5}{2}\right)^2 = 15.90 \, SQ. FT.$

$g = 32.2 \, FT/SEC^2$

H VARIES

$C = .61$ FROM TABLE 4-5 & 4-6
     BRATER & KING

$d = 4.5 \, FT.$

HEAD MEASURED TO CENTER OF PIPE

ELEVATION (FT)	H (FT)	Q (CFS)
135.5	3.5	146
136.0	4.0	156
137.0	5.0	174
138.0	6.0	191
140.0	8.0	220
142.0	10.0	246
144.0	12.0	270
146.0	14.0	291
148.0	16.0	311
150.0	18.0	330
152.0	20.0	348
154.0	22.0	365
156.0	24.0	381
158.0	26.0	397
159.0	27.0	404

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAM DAM_
OUTLET PIPE RATING

S.O. No. ___
Sheet No. _11_ of _24_
Drawing No. ___

Computed by _GWT_   Checked by _LAD_   Date _5/1/81_

PIPE FLOW

$$Q = \frac{A(2gH)^{1/2}}{[1 + K_E + K_b + K_c(L)]^{1/2}}$$

$$= \frac{15.90(64.4H)^{1/2}}{[1 + .78 + 1.2 + (.0072)(84)]^{1/2}}$$

$$Q = 67.39\ H^{1/2}$$

ELEVATION (FT)	H (FT)	Q (CFS)
136.0	2.8	113.
137.0	3.8	131.
138.0	4.8	148.
140.0	6.8	176.
142.0	8.8	200.
144.0	10.8	221.
146.0	12.8	241.
148.0	14.8	259.
150.0	16.8	276.
152.0	18.8	292.
154.0	20.8	307.
156.0	22.8	322.
158.0	24.8	336.
159.0	25.8	342.

$A = \pi R^2 = \left(\frac{4.5}{2}\right)^2 \pi = 15.90\ SQ.FT.$

$g = 32.2\ FT/SEC^2$

H VARIES AND IS MEASURED FROM THE TOP OF PIPE ELEV. AT THE OUTLET

$L = 84\ FT.$

$K_E (K_e) = 0.78\ PG.\ 5.5-6$
SCS NEH-5

$K_b (K_s) = .80\ PG.\ 5.5-10\ (2\ Bends)$
SCS NEH-5

$K_c (K_p) = .0072\ PG.\ 5.5-4$
SCS NEH-5

$n = .017$

TOP OF PIPE AT OUTLET
ELEV. — 133.2 FT.

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAM DAM_

OUTLET PIPE RATING SUMMARY

S.O. No. _____

Sheet No. _12_ of _24_

Drawing No. _____

Computed by _GWT_ Checked by _LAD_ Date _5/1/81_

OUTLET PIPE RATING SUMMARY

ELEVATION (FT)	q (CFS)
129.7	0
132.0	60
133.0	131
137.0	131
138.0	148
140.0	176
142.0	200
144.0	221
146.0	241
148.0	259
150.0	276
152.0	292
154.0	307
156.0	322
158.0	336
159.0	342

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _GLENHAM DAM_
PMF DISCHARGE

S.O. No. _____
Sheet No. _13_ of _24_
Drawing No. _____
Computed by _GWT_ Checked by _WDL_ Date _4/28/81_

WEIGHTED C_p VALUE FOR DRAINAGE AREA
WEIGHTED RAINFALL VALUE FOS SPS
    FISHKILL CREEK

SUBAREA	AREA	C_p	T_p	RAINFALL
1	76.4	.42	13.50	12.31
2	7.95	.35	6.20	13.69
3	58.5	.48	15.44	12.00
4	15.6	.43	6.44	12.20
5	31.5	.44	8.00	11.61

$$\frac{83.63}{189.95} = 0.44 \quad C_p \text{ WEIGHTED}$$

$$\frac{2,307.35}{189.95} = 12.15 \quad \text{RAINFALL WEIGHTED}$$

SPS Q AT NODE 103 IS 26,207 CFS
    (FROM "LOWER HUDSON RIVER BASIN HYDROLOGIC FLOOD
        ROUTING MODEL" PAGES 79-88)

HYDROGRAPH DEVELOPED AT NODE 103 USING $t_p = 10.0$ HR.
AND $C_p = 0.44$ WITH A RAINFALL OF 12.15 INCHES
PRODUCED A FLOW OF 28,535 C.F.S. THE PMP RAINFALL
AMOUNT WAS THEN SUBSTITUTED TO GET THE
PMF FLOWS.

RAINFALL DATA

    DAM AND DRAINAGE AREA ARE IN ZONE 2
    PMP (24 HR) 200 m_i^2 = 22.0 IN.
    DRAINAGE AREA = 188.57 SQ. MI.
    PMP (6 HR) — 74% PMP (24 HR) 200 SQ.MI.
    PMP (12 HR) — 89% "   "   "
    PMP (24 HR) — 100% "   "   "
    PMP (48 HR) — 105% "   "   "

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Subject _GLENHAM DAM_ S.O. No. _____

SPILLWAY CAPACITY ANALYSIS Sheet No. _14_ of _24_

Drawing No. _____

Computed by _GWT_ Checked by _LAD_ Date _5/27/81_

33 % PMF

MINIMUM TOP OF
DAM ELEV. 169.6 FT.

% PMF

ELEVATION (FT)
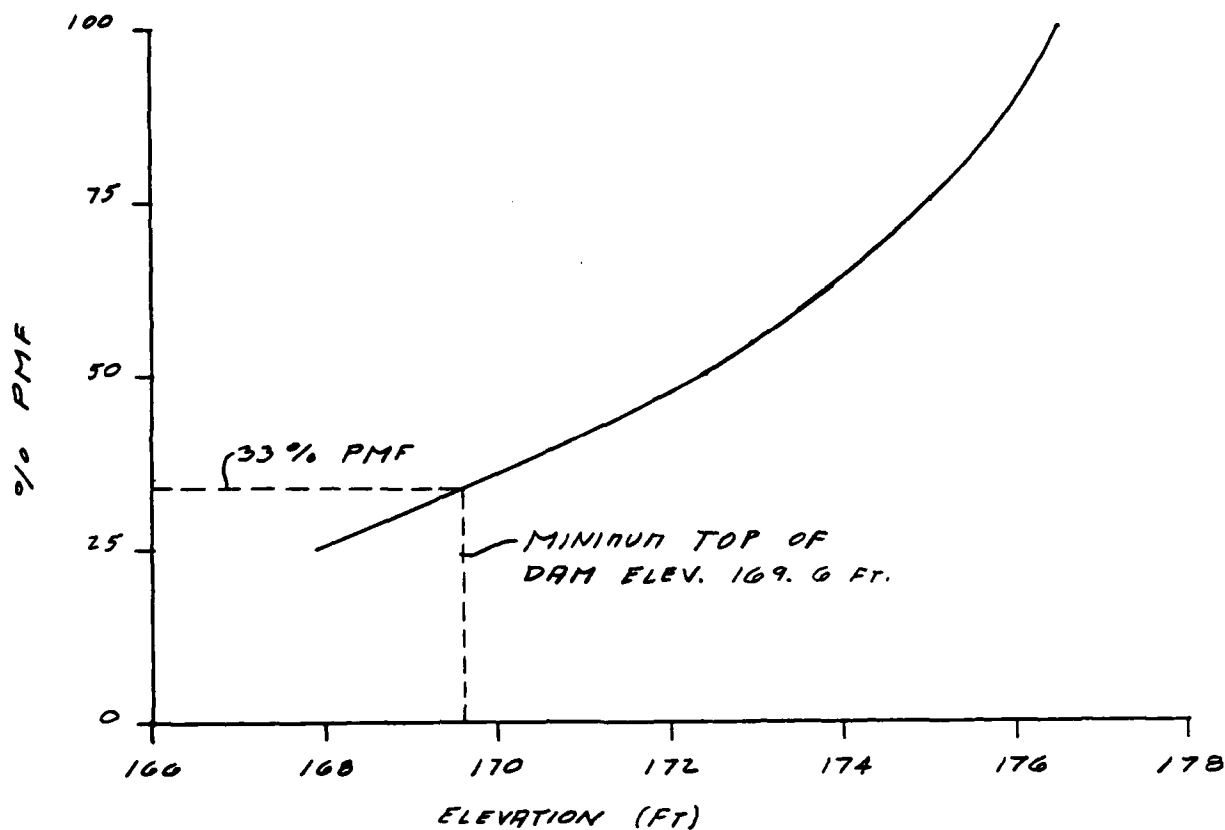
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************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION    JULY 1978
LAST MODIFICATION    20 FEB 79
ADD UPDATE           04 JUN 79
************

     A1      NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
     A2      HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLENHAP DAM
     A3      UNIT HYDROGRAPH BY SNYDERS METHOD
 4   B1   300    5      1
 5
 6   I1          5      1
 7                0.75   0.50   0.25   0.01
 8
 9   J1   1.0
10   K    1.0                        -1
11   M    RUNOFF HYDROGRAPH TO DAM
12   P    1    188.57    74     82     102    102
13
14   X    40.0   .44
15   Y   -1.5   -0.05    2.0
16   K                              -1
17   KI   ROUTING FOR GLENHAP DAM
18   Y    1
19   Y4   159.0   160    161    162    163    165    167   159.0   171
20   Y6          172    179    182
21   Y6   0    467.6  2051.6  4405.7  6278.4  8250.9  12798.1  18062.9  14761.1  23977.1
22   Y5   37542  53218.4  71274.3
23   SA   0      1.0    1.45   1.55   1.72   9.221  1.201
24   SE   129.7  141.8  155    160    170    180    190
25   SB   152.0
26   SD   167.0  2.7    1.5    166    179
27   AL   169.0  21     134    174    179    180    175
28   IV   109.6  170.0  171    172    173    175    180    185    190    1100   1133
29   K    99
```

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*****************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
CIVI SAFETY VERSION      JULY 1978
LAST MODIFICATION    26 FEB 79
MOD UPDATE           04 JUN 79
*****************

RUN DATE 02/21/11
TIME     14.37
```

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF GENERAL DAM
UNIT HYDROGRAPH BY SNYDERS METHOD

JOB SPECIFICATION

NO	NHR	VMIN	IDAY	IHR	IMIN	METRG	IPLT	IPKT	NSTAN
300	2	0	JCPER	IHI	LKUPI	IKAPE	0	-4	0
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
KPLAN= 1 NRTIU= 5 LRTIC= 1
RTIIS= 1.00 0.15 0.20 0.25 0.94

*****************   *****************   *****************

SUB-AREA RUNOFF COMPUTATION

RUNOFF HYDROGRAPH TO CAM

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INALE	ISTAGE	IAJTO
1	0	0	0	0	0	-1	0	0

HYDROGRAPH DATA
IRYOG	IUHG	TAREA	SNAP	TRSDA	TRSPL	RATIO	ISMIN	ISARL	LLLAI
1	1	188.57	0.0	188.57	0.0	0.0	0	0	0

PRECIP DATA
SPFE	PMS	R6	R12	R24	R48	R72	R96	R99
0.0	22.00	74.00	89.00	100.00	105.00			0.0

LOSS DATA
LRUPT	SIRKR	CLIKR	STLKK	ERAIN	SIKKS	RTIOR	SIRIL	CNSTL	ALSRA	RTIMP
0	0.0	0.0	1.00	0.0	0.0	1.00	0.20	0.42	0.0	0.0

UNIT HYDROGRAPH DATA
IP= 10.00   CP=0.649   TLA= 0

RECESSION DATA
STRTQ= -1.20   QRCSN= -0.02   RTIOR= 2.00

UNIT HYDROGRAPH 46 END-OF-PERIOD ORDINATES, LAG= 10.05 HOURS, CP= 0.44 VOL= 1.00

```
399.    1402.    2962.    4375.    2261.    5252.    4716.    2750.    2590.
2912.   2513.    2214.    2007.    1195.   1509.   1309.    1225.   1002.    900.
965.    747.     500.     583.     315.    432.    402.    325.    314.    277.
1.      1.       1.       1.       1.
```

TRSPC COMPUTED BY THE PROGRAM IS 0.881

MO.DA HR.MI PERIOD PAIN EXCS LOSS END-OF-PERIOD FLOW COMP Q MO.DA HR.MI PERIOD RAIN EXCS LOSS COMP Q

SU4 20.35 11.73 8.62 730641.
(517.11 258.11 219.1(2039..55)

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTING FOR GLENHAM DA4

	ISTAQ	ICOMP	IECCR	ITAPE	JPLT	JPRT	IN4T	ISTAGE	IAJIU
	2	1	C	0	0	0	-1	0	0

ROUTING DATA
QLOSS	CLOSS	AVG	IRFS	ISAME	IUP1	IPMP		LSTR	
0.0	0.0	0.0	10	1	0	0		0	

	NSTPS	NSTDL	LAG	AMSKK	X	ISK	STORA	ISPRAI	
	1	C	C	0.0	X	0.0	-159.	-1	

| STAGE | 159.00 | 161.00 | 162.00 | 163.00 | 165.00 | 167.00 | 169.00 | 169.00 | 171.00 |
| | 173.00 | 183.00 | | | | | | | |

| FLOW | 0.0 | 467.60 | 1405.70 | 2691.60 | 4216.40 | 6250.90 | 8250.90 | 12798.10 | 18002.90 | 19761.10 | 23577.10 |
| | 33542.00 | 53218.40 | 71274.25 | | | | | | |

SURFACE AREA=	0.	1.	1.	2.	2.	2.	7.	7.	
CAPACITY=	C.	4.	25.	26.	44.	84.	151.		
ELEVATION=	130.	142.	159.	160.	170.	180.	190.		

| | CREL | SPRIG | CCJW | EXPW | ELEVL | CUOL | CARLA | EXPL | |
| | 159.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |

DA1 DATA
| | TOPEL | CCGJ | EXPD | DAMWID |
| | 169.6 | 2.7 | 1.5 | 106. |

| CREST LENGTH AT CR BELLW ELEVATION | 0. | 21. | 174. | 175. | 185. | 900. | 1000. | 1150. | 1500. |
| | 169.6 | 170.0 | 171.0 | 172.0 | 173.0 | 172.0 | 180.0 | 185.0 | 190.0 |

PEAK OUTFLOW IS   63562. AT TIME 50.00 HOURS

PEAK OUTFLOW IS   45420. AT TIME 50.00 HOURS

PEAK OUTFLOW IS   30286. AT TIME 50.00 HOURS

PEAK OUTFLOW IS   15142. AT TIME 50.00 HOURS

PEAK OUTFLOW IS   695. AT TIME 50.00 HOURS

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

					RATIOS APPLIED TO FLOWS		
OPERATION	STATION	AREA	PLAN	RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5
				1.00	0.75	0.50	0.22	0.01
HYDROGRAPH AT	1	188.57	1	60504.	45378.	30222.	12126.	902.
		(488.39)	(1713.2511	1284.9711	856.8511	428.3211	17.1311
ROUTED TO	2	188.57	1	60562.	45420.	30266.	12142.	902.
		(488.39)	(1714.5211	1286.1411	857.6111	428.7711	17.1411

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	159.00	159.00	169.00
STORAGE	25.	25.	11.
OUTFLOW	0.	0.	19701.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	176.50	6.90	64.	60532.	20.00	50.00	0.0
0.75	175.01	5.41	58.	45420.	22.00	50.00	0.0
0.50	172.41	2.81	49.	30230.	12.00	50.00	0.0
0.25	167.89	0.0	40.	15142.	0.0	50.00	0.0
0.01	160.15	0.0	27.	635.	0.0	50.00	0.0

```
***********
* FLOOD HYDROGRAPH PACKAGE (HEC-1)
* DAM SAFETY VERSION
* LAST MODIFICATION  28 FEB 75
* MOD UPDATE         04 JUN 75
***********         JULY 1978

         NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
         HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLENFAM DAM
         DEWATERING ANALYSIS OF GLENFAM DAM

 A1       0       5       3       0       0       0       0
 A2     100
 B1       1
 J1       1       0
 K1                                              -1
 K2                                                      -1
 K1
 KX               NULL RUNOFF HYDROGRAPH TO DAM
                  188.57         188.57
 KX              -1

              DEWATERING GLENFAM DAM
                   1               2

 Y1       1       132     133     137     138     140     140     -1
 Y6     129.7     152     154     156     128     122     172     142     146     148
 Y6       0        60     131     131     16d     172     200     221     241     459
 Y5       0       292     307     322     336     342
 Y5     276       1.0     1.45    1.25    1.992   6.52    1.91
 3A       0       141.8   155     160     170     130     170
 3E     129.7
 5S     155.0
 5U     164.6     2.7      1.5     102
 K        99
```

HEC HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION   JULY 1978
LAST MODIFICATION   28 FEB 79
MOD UPDATE   04 JUN 79

RUN DATE 05/27/81
TIME 15.44

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
HYDROLOGIC AND HYDRAULIC ANALYSIS OF GLENHAM DAM
DEWATERING ANALYSIS OF GLENHAM DAM

JOB SPECIFICATION

NJ	NHR	NMIN	IDAY	IPH	IMIN	METRC	IPLT	IPKI	NSTAN
ICO	0	5	0	0	0	0	0	0	0
			JLPER	NHT	LRDPT	IRSGE			
			5	0	0	0			

MULTI-PLAN ANALYSES TO BE PERFORMED
APLAN= 1 NRTIO= 1 LRTIO= 1

RTIOS= 1.00

***********   ***********   ***********   ***********

SUB-AREA RUNOFF COMPUTATION

NULL RUNOFF HYDROGRAPH TO DAM

ISTAQ	ICOMP	JECON	ITAPE	JPLT	JPRT	JNATE	ISTAGE	IAUTO
1	0	0	0	0	0	-1	0	0

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LLCAL
-1	0	189.57	0.0	186.57	0.0	0.0	0	0	0

INPUT HYDROGRAPH

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.

PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	0.	0.	0.	0.	0.
CMS	0.	0.	0.	0.	0.
INCHES		0.0	0.0	0.0	0.0
MM		0.0	0.0	0.0	0.0
AC-FT		0.	0.	0.	0.
THOUS CU M					

HYDROGRAPH AT STA   1 FOR PLAN 1, RATIO 1

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	0.	0.	0.	0.	0.
CMS	0.	0.	0.	0.	0.
INCHES	0.	0.0	0.0	0.	0.0
MM	0.	0.	0.0	0.0	0.
AC-FT					0.
THOUS CU M					0.

*********   *********   *********   *********   *********   *********

HYDROGRAPH ROUTING

DEWATERING GLENFAR DAM

ISTAQ	ICCMP	IECON	ITAPE	JPLT	JPRT	INAAE	ISTAGE	IAUTO
2	1	0	0	0	0	-1	0	0

ROUTING DATA

NLSS	CLUSS	AVG	INES	ISAME	ICPT	IMP	ISK	LSIK
0.0	0.0	0.0	10	1	0	0	0	0

NSIPS	ASTDL	LAG	AMSKK	X	TSK	STORA	ISPRAI
1	0	0	0.0	0.0	0.0	-134.	-1

STAGE	129.70	132.00	133.00	137.00	138.00	140.00	142.00	144.00	146.00	148.00
	150.00	152.00	154.00	156.00	158.00	159.00				

FLOW	0.0	63.00	131.00	121.00	148.00	176.00	200.00	221.00	241.00	459.00
	276.00	292.00	307.00	322.00	336.00	342.00				

SURFACE AREA=	0.	1.	1.	2.	2.	7.	7.
CAPACITY=	0.	4.	25.	26.	44.	84.	151.
ELEVATION=	136.	142.	159.	100.	175.	185.	196.

DAM DATA

CREL	SPWIC	CQW	EXPA	ELEV	ELEVL	CGDL	CARLA	EXPL
159.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

TOPEL	COWD	EXPD	DAM.ID
159.6	2.7	1.0	100.

STATION   2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

.MTDA	HRAMN	PERIOD	FLWS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	0.05	1	0.04	0.	0.	2.	159.0

					129.7
1.01	5.45	63	5.75	0.	0.	0.	129.7
1.01	5.50	70	5.81	0.	0.	0.	129.7
1.01	5.55	71	5.92	0.	0.	0.	129.7
1.01	6.00	72	6.03	0.	0.	0.	129.7
1.01	6.05	73	6.08	0.	0.	0.	129.7
1.01	6.10	74	6.17	0.	0.	0.	129.7
1.01	6.15	75	6.25	0.	0.	0.	129.7
1.01	6.20	76	6.33	0.	0.	0.	129.7
1.01	6.25	77	6.42	0.	0.	0.	129.7
1.01	6.30	78	6.50	0.	0.	0.	129.7
1.01	6.35	79	6.58	0.	0.	0.	129.7
1.01	6.40	80	6.67	0.	0.	0.	129.7
1.01	6.45	81	6.75	0.	0.	0.	129.7
1.01	6.50	82	6.83	0.	0.	0.	129.7
1.01	6.55	83	6.92	0.	0.	0.	129.7
1.01	7.00	84	7.00	0.	0.	0.	129.7
1.01	7.05	85	7.09	0.	0.	0.	129.7
1.01	7.10	86	7.17	0.	0.	0.	129.7
1.01	7.15	87	7.25	0.	0.	0.	129.7
1.01	7.20	88	7.33	0.	0.	0.	129.7
1.01	7.25	89	7.42	0.	0.	0.	129.7
1.01	7.30	90	7.50	0.	0.	0.	129.7
1.01	7.35	91	7.59	0.	0.	0.	129.7
1.01	7.40	92	7.67	0.	0.	0.	129.7
1.01	7.45	93	7.75	0.	0.	0.	129.7
1.01	7.50	94	7.83	0.	0.	0.	129.7
1.01	7.55	95	7.92	0.	0.	0.	129.7
1.01	8.00	96	8.00	0.	0.	0.	129.7
1.01	8.05	97	8.08	0.	0.	0.	129.7
1.01	8.10	98	8.17	0.	0.	0.	129.7
1.01	8.15	99	8.25	0.	0.	0.	129.7
1.02	8.20	100	8.33	0.	0.	0.	129.7

PEAK OUTFLOW IS   SEC. AT TIME   0.5C HOURS

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	26C.	46.	33.	33.	3541.
CMS	10.	1.	1.	1.	92.
INCHES		0.C0	0.00	0.00	0.00
MM		0.C6	0.06	0.06	0.03
AC-FT		23.	23.	23.	23.
THOUS CU M		28.	28.	28.	28.

APPENDIX D

REFERENCES

REFERENCES

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17. U.S. Army, Office of the Chief of Engineers, Engineer Technical Letter No. ETL 1110-2-234, "Engineering and Design, National Program of Inspection of Non-Federal Dams, Review of Spillway Adequacy," Corps of Engineers, Washington, D.C., 10 May 1978.

APPENDIX E

DRAWINGS

CONTENTS

-N-

Castle Point

U S VETERANS
HOSPITAL

Agric And Tech
Institute

Red Sch

Beulah Ch

MATTEAWAN STATE HOSPITAL

Sewage
Disposal

Water

GLENHAM DAM

Glenham

Glenham
Sch

DOWNSTREAM
HAZARDS

Greenville

NEW YORK

Athletic
Field

Beacon
Memorial

F   I   S   H   K

SCALE 1:24000

| 1 | | 1/2 | | 0 | | | 1 MILE |

| 1000 | 0 | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 FEET |

| 1 | | .5 | | 0 | | | 1 KILOMETER |

LOCATION PLAN
GLENHAM DAM
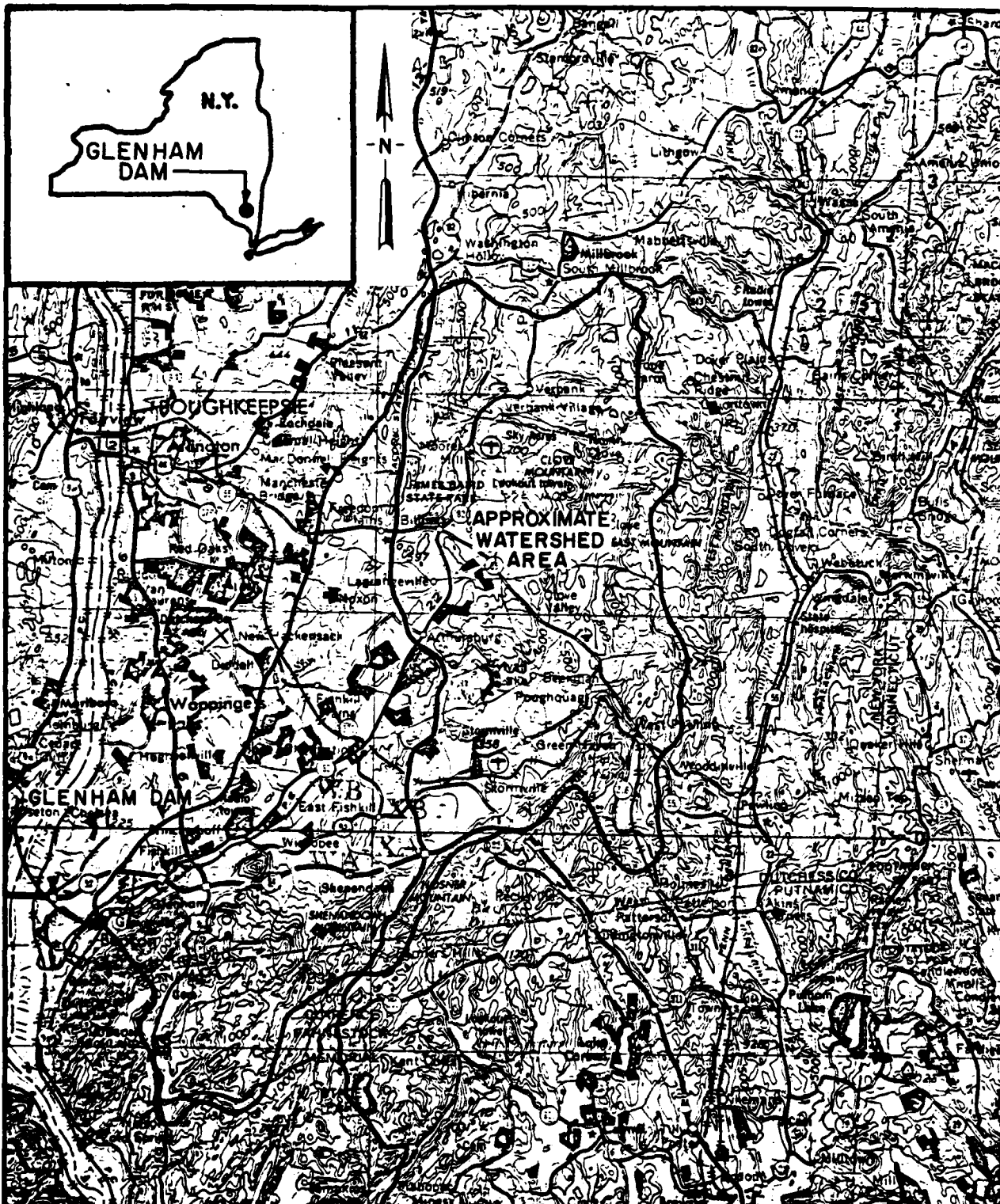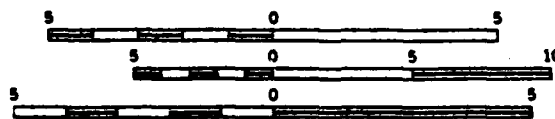
Scale 1:250,000

REFERENCES:
1. U.S.G.S. 1:250,000 HARTFORD, CONN., N.Y., N.J., MASS.
QUADRANGLE, PHOTOREVISED 1975

FIELD SKETCH
GLENHAM DAM, N.Y.
MICHAEL BAKER Jr. Inc
8 MARCH 1981
—Not to Scale—

RIGHT ABUTMENT

N

SPIDER FENCE

RESERVOIR

SEEP 0.5 g.p.m ←
SEEP 5-10 g.p.m ←

←TRASH RACK

VALVES CONTROLLING FLOW TO FACTORY

SEEP 3 g.p.m. FLOWING INTO BOX

VALVE FOR OUTLET PIPE

CUT STONE PLATES

8.5' CREST

LEFT ABUTMENT

SEEP 0.5 g.p.m ←

6.5' WIDE ROUNDED CREST

DOWNSTREAM FACE OF OGEE SPILLWAY SLOPE- 1H:1V

STEEP ROCK FACE

SEEP 5 g.p.m ←
SEEP 1 g.p.m ←
SEEP 2 g.p.m.

CUT STONE PLATES

CUT STONE PLATES

DISCHARGE END OF OUTLET PIPE

TOE OF SPILLWAY

SEEP 10 gpm ←

STILLING BASIN

FACTORY
(BEACON TEXILE PRINTERS LTD.)

SIDE CHANNEL

2' WIDE CONCRETE WALL

CONCRETE BERM

CUT STONE RIVER WALL →

DOWN STREAM CHANNEL

NOTES: 1) SURFACES CAPPED WITH CUT STONE PLATES HAVE WEEDS AND BRUSH GROWING IN NEARLY EVERY JOINT.

2) VIRTUALLY EVERY CONCRETE SURFACE SHOWS SIGNS OF SPALLING

PLATE 1

Plant at Glenham N.Y.

With Proposed Alterations

For

Loeb & Schoolfield Co.
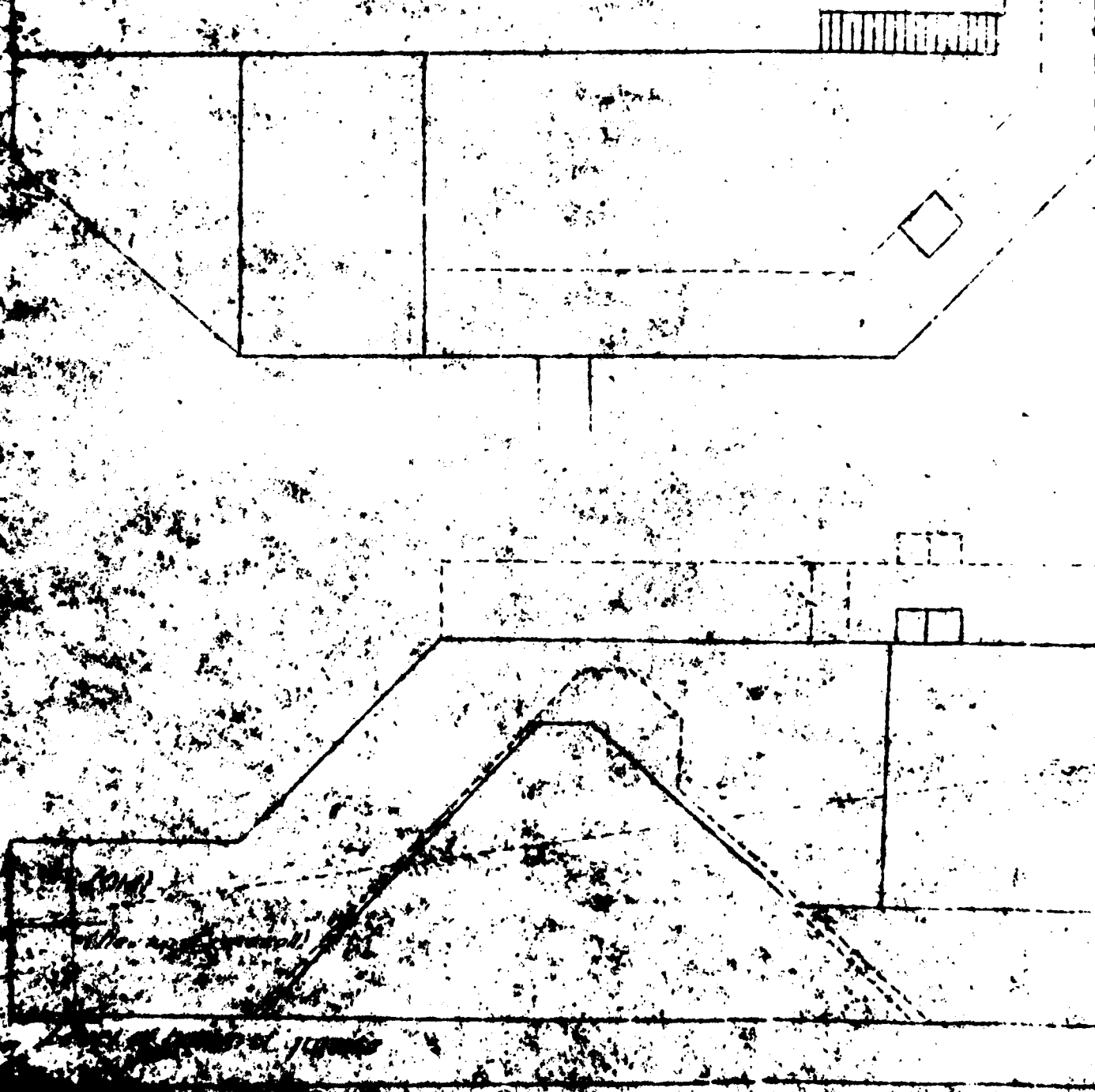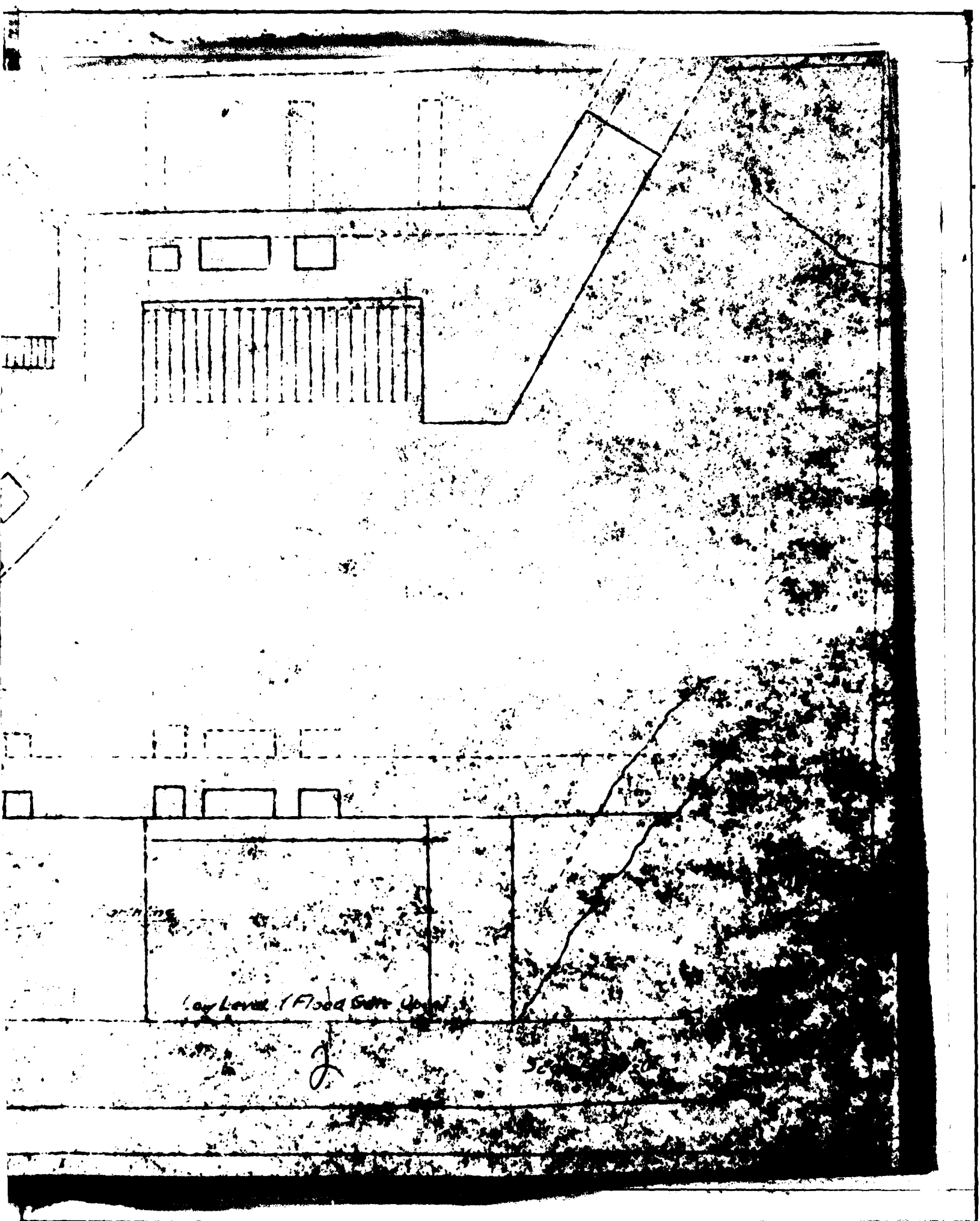
Low Level (Flood Gate Open)
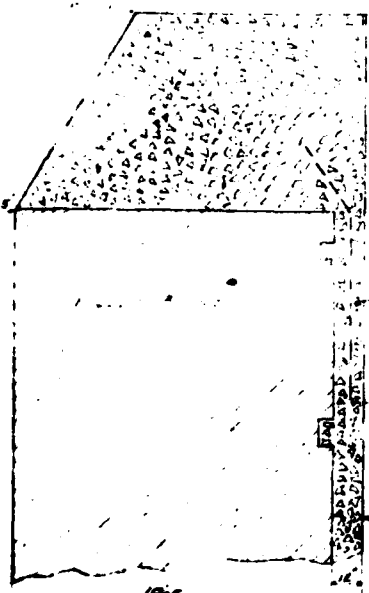
Waterproof Lining
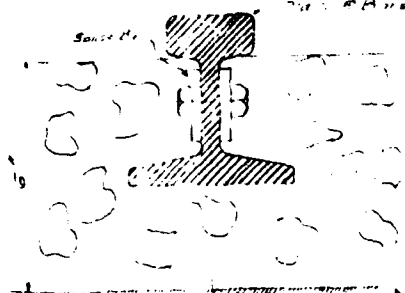
Section Showing Protection of
Rock Straight Face of Dam

Section B-B

Section A-A

Note Depth Varies. Footing Courses
to be carried down to rock
hard Pan

Typical Elevation of Wing Wall

Iron rods
.. ground to cut
and pass ....

D.D
and Piers
.. Dam
.. IPI
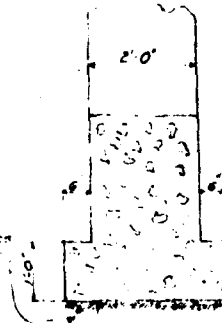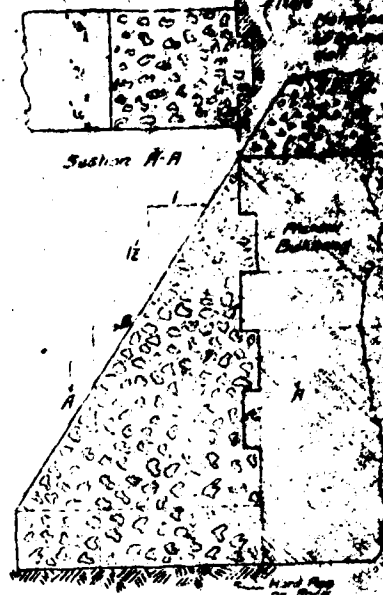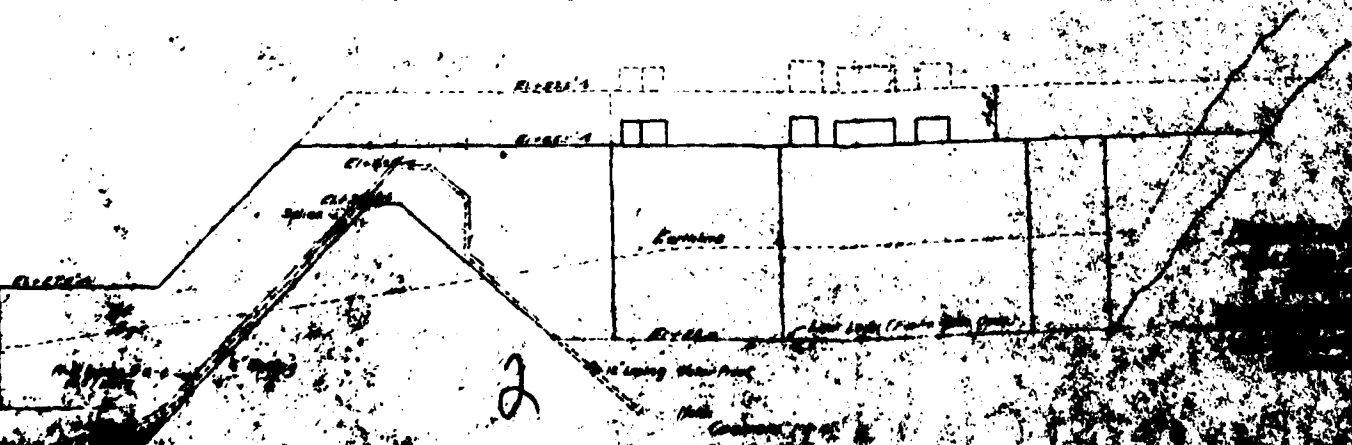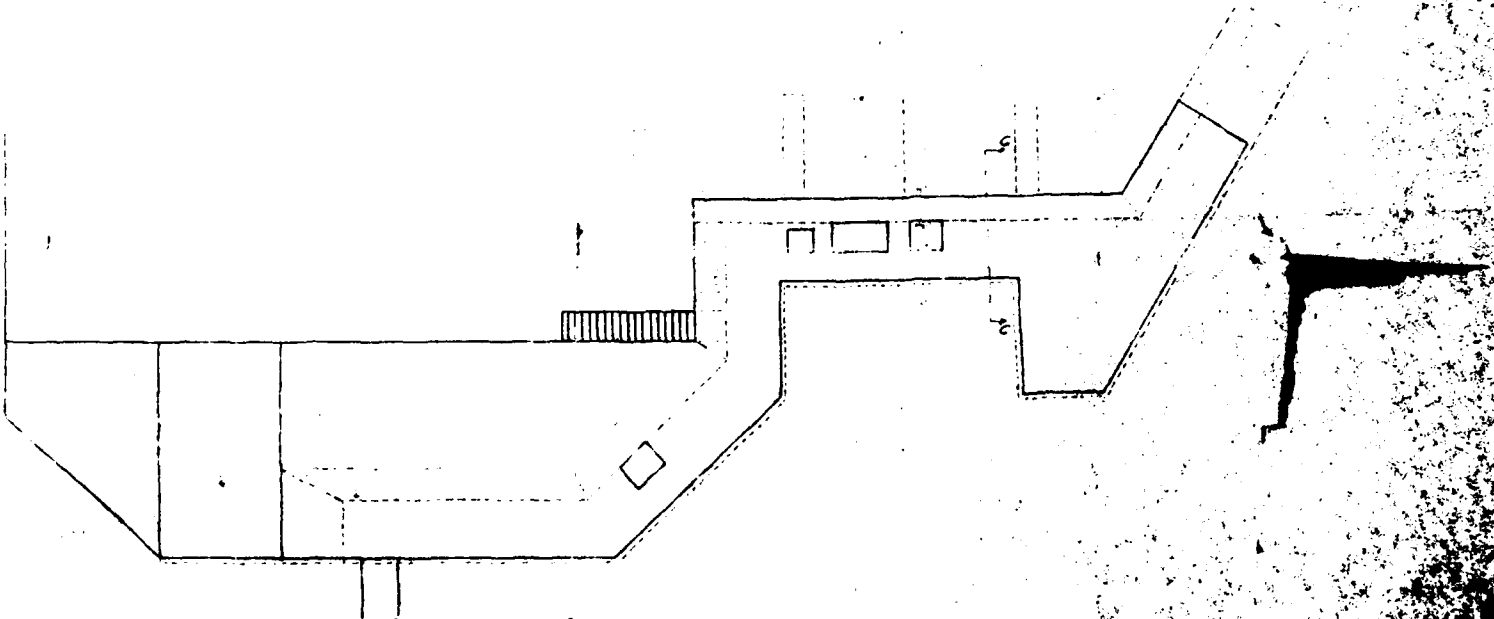
REPAIRS TO DAM AND BULKHEAD.

GLENHAM EMBROIDERY CO.

GLENHAM N.Y.

2

Note Notches 18½×16"
to be cut in old wall

Section BB

Present
Bulkhead

Hardpan or rock
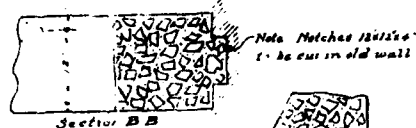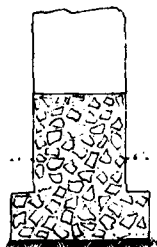
Section CC

Scale ¼ = 1ft
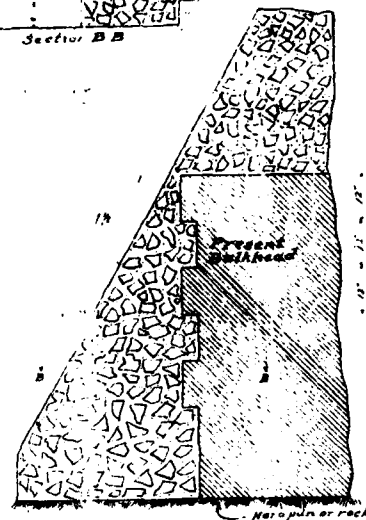
Typical elevation of Wing Wall
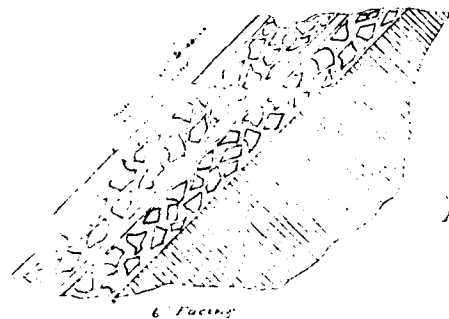
Section H H

Showing Protection of Down Stream
Face of Dam

Scale 3' = 1 ft

6" Facing

1" Iron rods justined
1" in Granite blocks
and spaced 1' apart

18' 0"

2' 0"
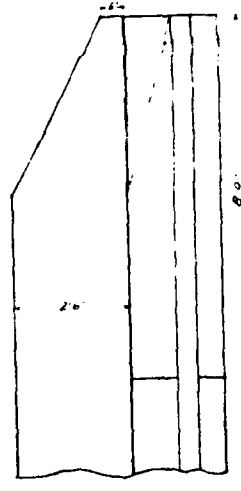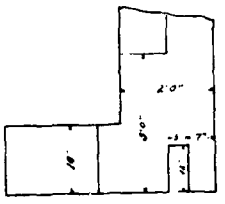
Section D.D

Wing walls and Piers
for Raceway Dam

Scale 3/8 = 1 ft

2' 0"

8' 0"

2

Present Roway.

2

APPENDIX F

BACKGROUND DOCUMENTS

DEC DAM INSPECTION REPORT

RB	CTY	YR. AP.	DAM NO.	INS. DATE	USE	TYPE
0 1	1 4	1 2	5 5 3	1 1 2 7 2	0 0 4	1

Industrial
Water Supply

AS BUILT INSPECTION

1 Location of Spillway and outlet		/ Elevations
/ Size of Spillway and outlet		/ Geometry of Non-overflow section

GENERAL CONDITION OF NON-OVERFLOW SECTION

1			
1 Settlement	/ Cracks	/ Deflections
1 Joints	/ Surface of Concrete	/ Leakage
1 Undermining	/ Settlement of Embankment	/ Crest of Dam
/ Downstream Slope	/ Upstream Slope	/ Toe of Slope

GENERAL CONDITION OF SPILLWAY AND OUTLET WORKS

1			
1 Auxiliary Spillway	/ Service or Concrete Spillway	/ Stilling Basin
1 Joints	1 Surface of Concrete	/ Spillway Toe
/ Mechanical Equipment	/ Plunge Pool	/ Drain

1 Maintenance	3 Hazard Class	
3 Evaluation	3 Inspector	

COMMENTS:

~~Texaco Research Center~~ Glenham Dam

Water now used in factory and for

Industrial use

555   LH

Map 212
Dam 555
L.H.

Form IW21. (18-10-2000 (16-12266)

(NOTICE: After filling out one of these forms as completely as possible for each dam in your district, return it at once to the Conservation Commission, Albany.)

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

DAM REPORT

...., 191........
(Date)

CONSERVATION COMMISSION,

DIVISION OF INLAND WATERS.

GENTLEMEN:

I have the honor to make the following report in relation to the structure known

as the _Glenham_ Dam.

This dam is situated upon the _Fishkill Creek_
(Give name of stream)

in the Town of _Fishkill_, _Dutchess_ County,

about _in_ from the Village or City of _Glenham_.
(State distance)

The distance _down_ stream from the dam, to the _Hudson River_,
(Up or down)   (Give name of nearest important stream or of a bridge)

is about _4 miles_.
(State distance)

The dam is now owned by _Glenham Woolery Co. / Glenham, N.Y./_
(Give name in full)

and was built in or about the year _1912_, and was extensively repaired or reconstructed

during the year, _undetermined. 914--15)_.

As it now stands, the spillway portion of this dam is built of _circle Co._
(State whether of masonry, concrete or timber)

and the other portions are built of _concrete_
(State whether of masonry, concrete, earth or timber with or without rock fill)

As nearly as I can learn, the character of the foundation bed under the spillway portion

of the dam is _fill shale_ and under the remaining portions such

foundation bed is _shale_.

The total length of this dam is____ _2 8 3_ ____ ____ feet. The spillway or waste-weir portion, is about____ _1 4 0_ ____ feet long, and the crest of the spillway is about____ _1 0_ ____ feet below the top of the dam.

The number, size and location of discharge pipes, waste pipes or gates which may be used for drawing off the water from behind the dam, are as follows: _one 5' pipe and_ _one 7' pipe at west end of dam_

State briefly, in the space below, whether, in your judgment, this dam is in good condition, or bad condition, describing particularly any leaks or cracks which you may have observed.)

Dam is very massive and tight, in very good condition. Concrete is good.

Reported by_ _Richard L. Hyde_ _
(Signature)

(Address—Street and number, P. O. Box or R. F. D. route)

(Name of place)

(SEE OTHER SIDE)

(In the space below, make one sketch showing the form and dimensions of a cross section through the spillway or waste-weir of this dam, and a second sketch showing the same information for a cross section through the other portion of the dam. Show particularly the greatest height of the dam above the stream bed, its thickness at the top, and thickness at the bottom, as nearly as you can learn.)
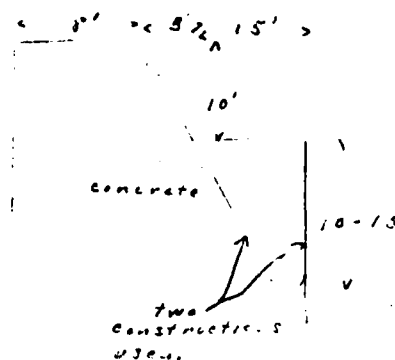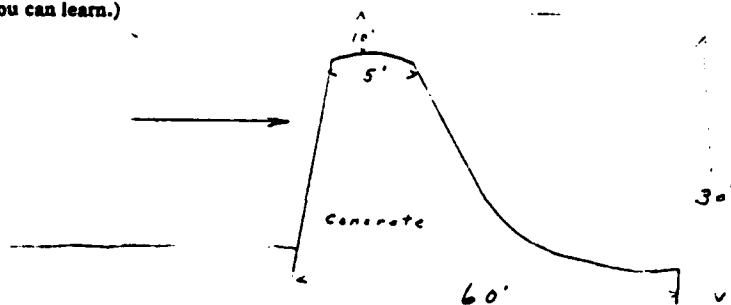
(In the space below, make a third sketch showing the general plan of the dam, and its approximate position in relation to buildings or other conspicuous objects in the vicinity.
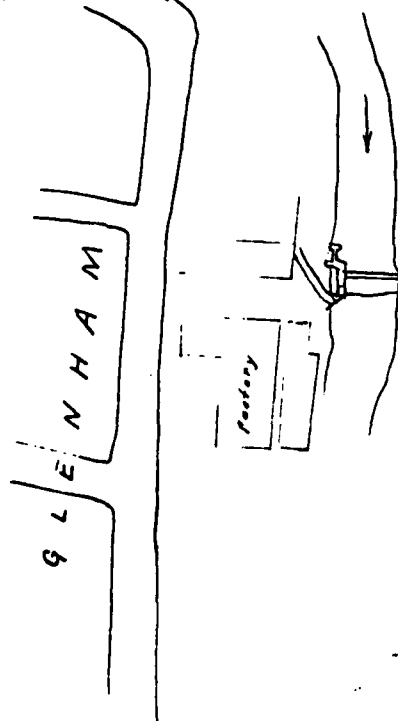
FRIEDMANN, ROBERTSON & KEELER
ARCHITECTS AND ENGINEERS
90 WEST STREET
NEW YORK

May 17th.,1916

Alex Rice McKim Esqr

Conservation Commission,

Albany,N.Y.

My dear Mr.McKim:-

In re Dam No.553 Lower Hudson Watershed.

Referring to our recent conversation regarding
the dam at Glenham New York,owned by the Glenham Embroidery
Company,I enclose two blue prints showing repairs to this
dam in 1911-1912

During 1914-1915 certain repairs and alterations
were made to the dam apron to prevent back scouring,and I
herewith enclose photographs showing the work as it progressed.

These repairs were completed early in 1915.

Yours very truly

2 2

END
DATE
FILMED
11 81
DTIC

Newburgh News

DEC 5 1914

NEW DAM IS BUILT FOR GLENHAM CO.

Modern Structure Supplants That of Long Ago

JOB A DIFFICULT ONE

Is One of Many Improvements Made at Plant—Factory Rushed With Orders

Special to The News.

Beacon, Dec. 5.—For the past four months, a small army of men—masons, carpenters, engineers and laborers, have been busily engaged in repairing and constructing dams, cutoff walls, bulkheads, water sheds, etc, for the Glenham Embroidery Co. This immense piece of engineering is practically completed and today water is once more running over the big dam east of the factory.

This dam, which is 35 feet high and 142 feet long, was built in 1876, and the vast amount of water, and—in the spring of the year—ice, which rushes over it, had torn away and undermined the base, or apron to such an extent that much repairing was necessary. The work has been in charge of the Murphy Bros., builders, of 30 East 42d street, New York city. Freedman, Robertson and Keeler also of New York city were the architects. The work was chiefly for the purpose of preventing the back scour of water from undermining the big dam. The construction of a cut-off wall, located 50 feet below the dam, which extends the entire width of the creek, also dropping down to solid rock, in some places a depth of 30 feet, has been completed. A new reinforced concrete apron connecting the cut-off wall with down stream face of dam has also been built. The top of the wall extends about four feet above the apron and forms a secondary reservoir or water cushion, adding an area of 140 square feet and a depth of four feet. The object of this cushion is to take the impact of the water and ice that flows over the crest of dam. This water cushion is so constructed, it drains itself by a system of locks.

The contractors have also been making an extension of 100 feet in length to the present raceway, with a twofold object of protecting the present sea wall from flood waters and also preventing the flood water from backing up against the water wheel and power plant.

In some places, holes 10 feet deep were dug by water in the old apron. In other places a man could crawl some 30 feet through the big openings.

A wooden flume about 8 by 8 was constructed 100 feet long to carry off water from the water wheel; also a temporary wooden cofferdam, extending the entire width of the creek at a distance of about 70 feet below the dam. This cofferdam was constructed to prevent the water from backing up and also for the safety of those employed in the work. Three pumps having a capacity of 4,000 gallons per minute were installed in pits, into which drained the water, seeping through the creek bottom. Thus a comparatively dry place for the men to work was afforded. In connection with the excavating, a trench 7 feet wide was dug to rock bottom and with heavy timber, a holdback was made from loose dirt and rock which might have interfered with the work. A cable way was installed from shore to shore for the purpose of handling machinery and such material used in this vast work. An average of 25 to 40 men a day have been employed on the contract.

The men engaged in such difficult and dangerous work were protected with such care and diligence that no accidents occurred either to men employed or the construction work itself. At times there was flowing through the temporarily flume, eight feet of water, six feet deep and at a velocity of 10 feet per second. The contract is now completed and adds another to the many improvements being made since the opening of the old mill by the Embroidery Co. The concern is at present very busy with the manufacture of their lace, due to the present conditions abroad. Fred D. Rhodes was the consulting engineer in charge. Under his personal supervision, the work has given perfect satisfaction.

JUL 30 1913

ENLARGE DAM AT GROVEVILLE

The Glenham Embroidery Company Raises Structure Seven Feet to Secure More Power

The large dam of the Glenham Embroidery Company is being heightened and widened to increase the water power of the engines of the mill. When completed the dam will be seven feet higher than the former structure and twenty feet wider. This will hold back a much larger quantity of water and greatly increase the power of the turbines. At present abut 50 men are at work on the dam and have the work nearly finished.

The extension of the equipment has been in progress ever since the plant first was opened. The growth of business has necessitated the installation of additional machinery and the prospects now are that this expansion will continue.

Poughkeepsie Enterprise

JUL 31 1913

MAKE BIG DAM AT GLENHAM 7 FEET HIGHER

The large dam of the Glenham Embroidery Company is being heightened and widened to increase the water power of the engines of the mill. When completed the dam will be seven feet higher than the former structure, and twenty feet wider. This will hold back a much larger quantity of water and greatly increase the power of the turbines. At present about 50 men are at work on the dam and have the work nearly finished.

The extension of the equipment has been in progress ever since the plant first was opened. The growth of business has additional machinery and the prospects now are that this expansion will continue.

FRED DANA RHODES
ASSOC. M. AM. SOC. C.E.
CONSULTING ENGINEER
FOUNDATIONS, STEEL STRUCTURES, EXPERT REPORTS
140 CEDAR STREET, NEW YORK
TELEPHONE 3084 CORTLANDT

Nov. 1, 1911.

State of New York Conservation Commission,
    Alexander Rice McKim, Inspector of Docks and Dams,
        Albany, N. Y.

Dear Sir:-

Please accept our thanks for yours of the 30th ultimo in relation to Fishkill Creek Dam, N.Y. The plans which we submitted are really tentative plans and some of our assumptions have been made on information from some of the men employed in the construction of the dam, together with shafts which we have sunk near the dam to determine so far as we are able the character of the soil. Two men who helped build the dam and whose names and addresses we have, informed us that the dam rested partly on rock and partly on hard-pan. The plant has been idle for some eighteen years and at the time our preliminary investigations were made we had no power with which to pump water out of the shafts which we desired to sink. We have proceeded on the theory that the dam rested partly on hard-pan and partly on rock, and it is our intention, when conditions are such that repairs can be undertaken, to construct a flume to carry off the waters from the flood gate which have thus far made it impossible to make a detailed examination. Within the past few weeks a steam plant has been put in operation, but the water has been so high that it did not seem advisable to start even the preliminary operations. We are informed that there was no core wall and that the dam was constructed entirely of broken stone and Rosendale cement. We think that the present leakage is probably due to the fact that some of the Rosendale cement is washed out. There is, however, no sign of either a crack or of slipping.

The order of procedure which we intend to follow is:
First--To waterproof the up-stream face of the dam without increasing
its present height, and at the same time to carry off the waste water
so that the toe will be entirely dry; then we should be able to know
whether there is any leakage or seepage between the base of the dam
and the soil or rock foundation. Second--To sink shafts at the toe of
the dam in order to determine precisely the character of the soil.
Third--In the event that there is no leakage and the soil is either
hard-pan or rock, to increase the height of the dam, as indicated on
the drawings. This particular work will be done in the following order:
constructing the wing walls of the bulkhead; increasing the height of
the bulkhead; surfacing and extending the down-stream face, and in-
creasing the height of the crest.
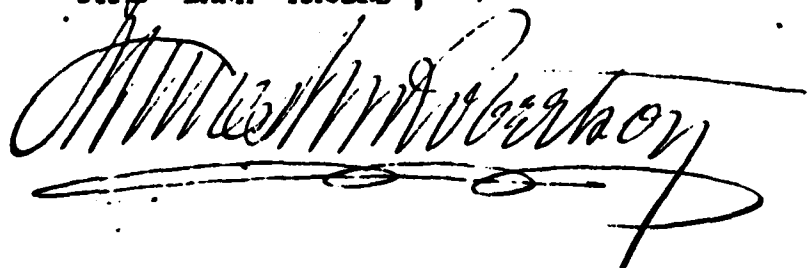
We desire to add that the dam was built about 1875.

Trusting that we may have notice of your approval of the
plans executed in accordance with the provisions of this letter, we
are,

Respectfully yours,

FRED DANA RHODES,

By

APPENDIX G

STABILITY COMPUTATIONS

MICHAEL BAKER, JR., INC.
THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _Glenham Dam_
Stability Analysis
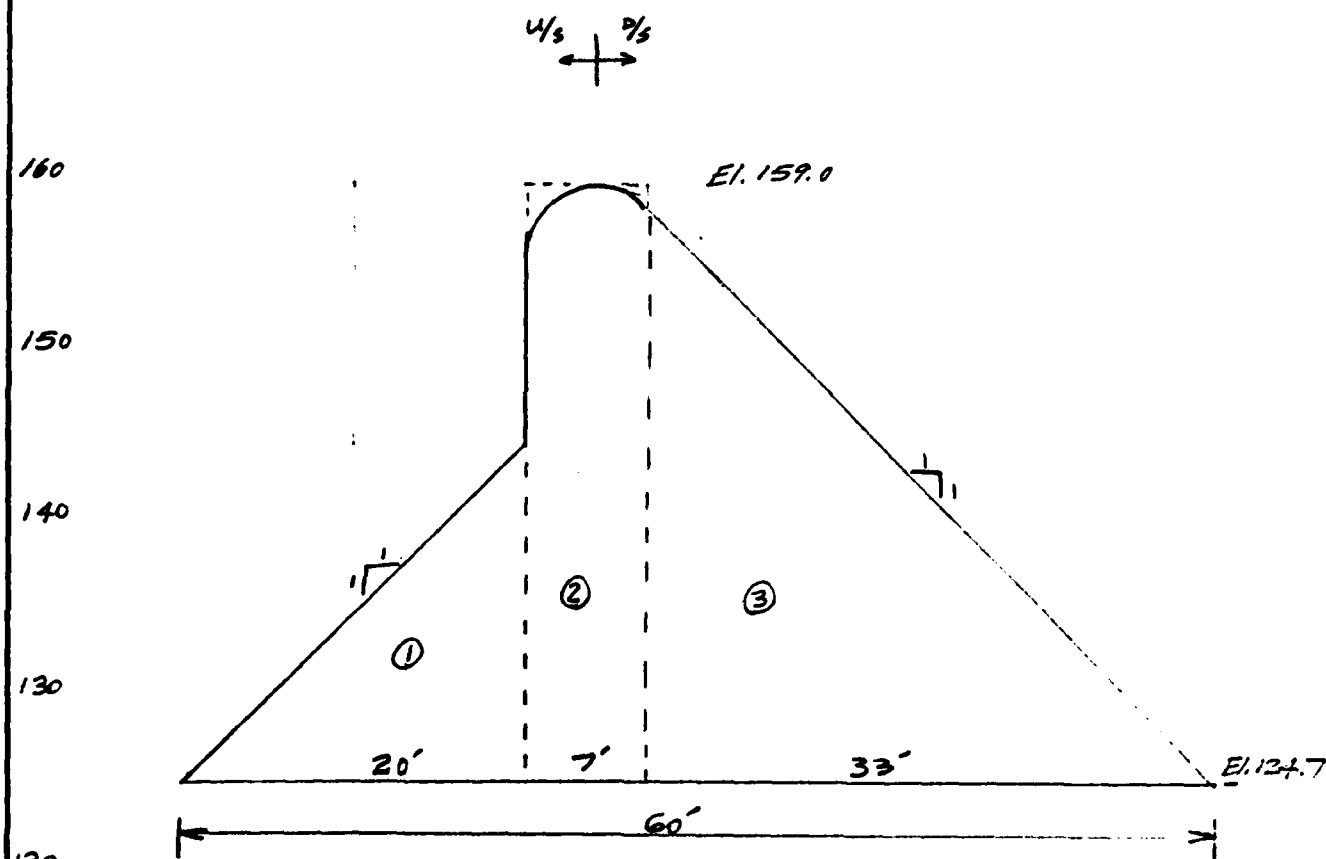_Overflow Section_
Computed by _JGU_   Checked by _YDD_

S.O. No. _13855-ARA_
Sheet No. _1_ of _7_
Drawing No. _____
Date _June 3, 1931_

SPILLWAY CROSS SECTION

Section	Ft³	γ $^k/_{Ft^3}$	W(k)	Moment Arm	Moment
① ½(20)(20)=	200	0.15	30	$40+\frac{20}{3}$	1400
② 7'(34.3)=	240.1	0.15	36.015	36.5	1314.548
③ ½(33)² =	544.5	0.15	81.675	⅔(33)	1796.35
			147.69		4511.398

Location of Weight Resultant = $\frac{4511.398}{147.69}$ = 30.55 Ft from Toe

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THE BAKER ENGINEERS

Box 280
Beaver, Pa. 15009

Subject _Glenham Dam_
Stability Analysis
Overflow Section
Computed by _JGU_   Checked by _MDS_

S.O. No. _13358-ARA_
Sheet No. _2_ of _7_
Drawing No. _____
Date _June 3, 1981_

CASE I — NORMAL POOL

Pool = El. 159.0 ft.   Tailwater @ El. of D/s sill = 128.1 ft

Uplift Force

Reservoir Side = $(159 - 124.7)(0.0625) = 2.144$ ksf

Tailwater Side = $(128.1 - 124.7)(0.0625) = 0.213$ ksf

Uplift Resultant = $\left(\dfrac{2.144 + 0.213}{2}\right)60 = 70.71$ kips

Uplift Resultant Location = $\dfrac{(0.213)(60)\left(\frac{60}{2}\right) + (2.144 - 0.213)\frac{1}{2}(60)(60)\frac{2}{3}}{70.71}$

$= 38.193$ Ft. From Toe

Hydrostatic Force

U/s $\frac{1}{2}(159 - 124.7)^2 (0.0625) = 36.765$ kips

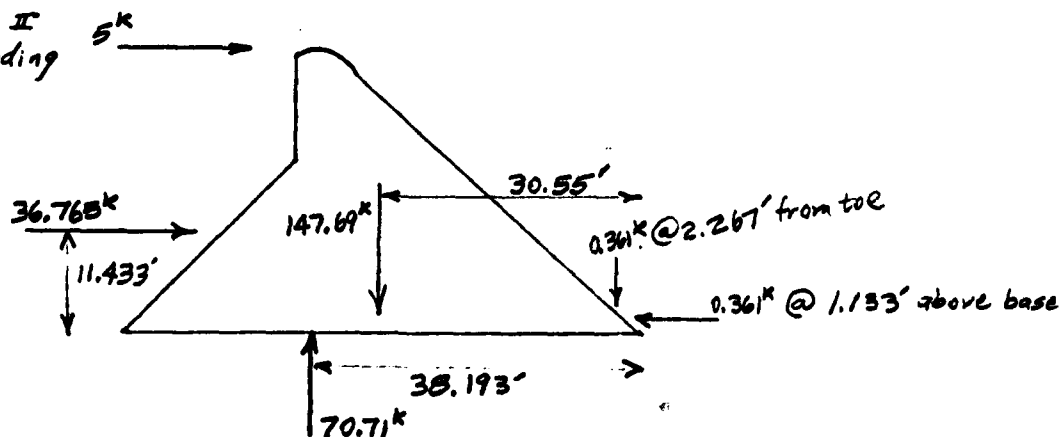U/s H.F. Resultant Location $34.3^{Ft}/3 = 11.433$ Ft above base

D/s $\frac{1}{2}(128.1 - 124.7)^2 (0.0625) = 0.361$ kips

D/s Tailwater Resultant Location = $3.4/3 = 1.133$ Ft.

Additional Weight Due to Tailwater

$\frac{1}{2}(3.4)^2 (0.0625) = 0.361$ kips

Location = $\frac{2}{3}(3.4) = 2.267$ Ft from Toe

Case I & II Loading Diagram

Case I
Ice Loading 5^k

36.765^k 11.433'   147.69^k 30.55'   0.361^k @ 2.267' from toe

0.361^k @ 1.133' above base

38.193'

70.71^k

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Subject _Glenham Dam_
Stability Analysis
Overflow Section

S.O. No. _13853-ARA_
Sheet No. _3_ of _7_
Drawing No. _____

Computed by _JGU_   Checked by _HDM_ Date _June 3, 1981_

Case I

$$F.S._{overturning} = \frac{\Sigma R}{\Sigma D} = \frac{(147.69)(30.55) + (0.361)(2.267) + (0.361)(1.133)}{(36.765)(11.433) + (70.71)(38.193)}$$

$$= \frac{4513.157}{3120.961} = \underline{1.446}$$

$F.S._{Sliding} = R/H$ where $R = \Sigma V \tan\phi + sA$

assume $\phi = 35°$ $s = 2 ksf$ $A = 60 \, ^{ft^2}/lf$

$R = (147.69 + 0.361 - 70.71)0.7 + 2(60)$

$\quad = 77.341(0.7) + 120$

$\quad = 174.139$

$\Sigma H = 36.765 - 0.361 = 36.404$

$F.S. = \frac{174.139}{36.404} = \underline{\underline{4.784}}$

Resultant Location $= \frac{\Sigma M}{\Sigma V} = \frac{4513.157 - 3120.961}{77.341} = \underline{13.001 \text{ ft from toe}}$

Middle $\frac{1}{3} = 40$ ft to 20 ft. from toe

Case I

$$F.S._{overturning} = \frac{4513.157}{3120.961 + (5)(34.3)} = \frac{4513.157}{3292.461} = \underline{1.371}$$

$$F.S._{sliding} = \frac{174.139}{36.404 + 5} = \frac{174.139}{41.404} = \underline{4.206}$$

$$\text{Resultant Location} = \frac{4513.157 - 3292.461}{77.341} = \underline{15.783 \text{ ft from toe}}$$

Subject _Glenham Dam_
Stability Analysis
Overflow Section
Computed by _JGU_   Checked by _GDH_

S.O. No. _13888-ARA_
Sheet No. _4_ of _7_
Drawing No. _____
Date _June 3, 1981_

Case III — ½ PMF
  max reservoir surface = El. 172.4 H_w = 47.7 ft
  max tailwater surface = El. 142.0 H_w = 17.3 ft

Uplift Force
  u/s $(47.7)(0.0625) = 2.981$ kips/s.f.
  Tailwater $(17.3)(0.0625) = 1.081$ kips/s.f.

  Uplift Resultant = $\left(\dfrac{2.981 + 1.081}{2}\right)60 = 121.86^k$

  Uplift Resultant Location = $\dfrac{(1.081)(60)\left(\frac{60}{2}\right) + (2.981-1.081)\frac{1}{2}(60)(60)\frac{2}{3}}{121.86}$

      $= 34.677$ ft. from toe

Hydrostatic Force
  u/s   top of dam = $(172.4 - 159.0)(0.0625) = 0.838$ ksf
       base of dam = $(172.4 - 124.7)(0.0625) = 2.931$ ksf
       Resultant = $\left(\dfrac{0.838 + 2.981}{2}\right)(34.3) = 65.496^k$

  u/s Resultant Location = $\dfrac{(0.838)(34.3)\left(\frac{34.3}{2}\right) + (2.981-0.838)(\frac{1}{2})(34.3)\left(\frac{34.3}{3}\right)}{65.496}$

      $= 13.942$ ft. above base

Tailwater $\frac{1}{2}(17.3)^2(0.0625) = 9.353^k$
  Tailwater Resultant Location = $\dfrac{17.3}{3} = 5.767$ ft. above base

Additional Weight due to Tailwater

  $\frac{1}{2}(17.3)^2(0.0625) = 9.353^k$
  Resultant Location = $\frac{2}{3}(17.3) = 11.533$ ft. from toe

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Subject __Glenham Dam__
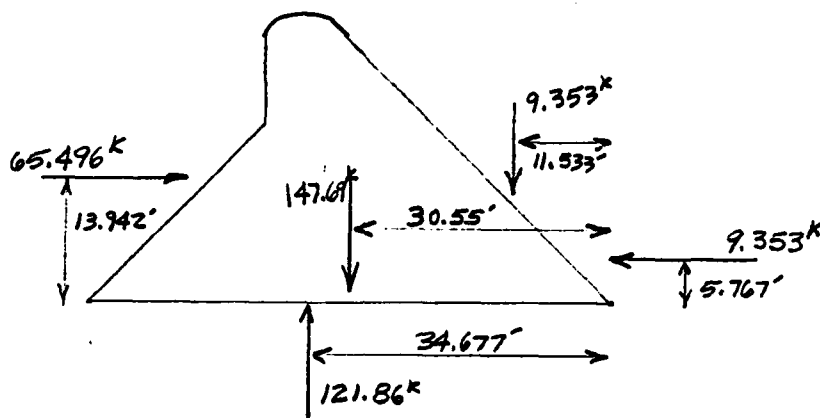__Stability Analysis__
__Overflow Section__
Computed by __JGU__   Checked by __YDB__

S.O. No. __13883-ARA__
Sheet No. __5__ of __7__
Drawing No. _____
Date __June 3, 1981__

Case III   Loading Diagram

$$F.S._{overturning} = \frac{(147.69)(30.55) + 9.353(11.533) + 9.353(5.767)}{(121.86)(34.677) + (65.496)(13.942)}$$

$$= \frac{4673.736}{5138.884} = \underline{0.909}$$

$F.S._{sliding} \Rightarrow$ $\phi = 35°$ $s = 2\ ksf$

$R = \Sigma V \tan\phi + sA$

$= (147.69 + 9.353 - 121.86)(0.7) + 2(60)$

$= (35.183)0.7 + 120 = 144.628$

$\Sigma H = 65.496 - 9.353 = 56.143$

$$F.S. = \frac{144.628}{56.143} = \underline{2.576}$$

$$RESULTANT\ LOCATION = \frac{\Sigma M}{\Sigma V} = \frac{4673.736 - 5138.884}{35.183} = \underline{-13.221\ ft}$$

Note: A negative means the resultant is
downstream from the toe

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Subject __Glenham Dam__
__Stability Analysis__
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S.O. No. __13883-ARA__
Sheet No. __6__ of __7__
Drawing No. _____
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Case IV - PMF

Max reservoir surface = 176.5 ft. H_w = 51.8 ft.

Max tailwater surface = 147.2 ft. H_w = 22.5 ft.

Uplift Force

u/s $(51.8)(0.0625) = 3.238$ ksf

Tailwater $(22.5)(0.0625) = 1.406$ ksf

Uplift Resultant = $\left(\dfrac{3.238 + 1.406}{2}\right) 60 = 139.32$ kips

Uplift Resultant Location = $\dfrac{(1.406)(60)\left(\frac{60}{2}\right) + (3.238 - 1.406)\frac{1}{2}(60)(60)\frac{2}{3}}{139.32}$

$\qquad = 33.945$ ft from toe

Hydrostatic Force

u/s top of dam = $(176.5 - 159.0)(0.0625) = 1.094$ ksf

base of dam = $(176.5 - 124.7)(0.0625) = 3.238$ ksf

Resultant = $\left(\dfrac{1.094 + 3.238}{2}\right)(34.3) = 74.294$ k

u/s Resultant Location = $\dfrac{(1.094)(34.3)\left(\frac{34.3}{2}\right) + (3.238 - 1.094)\frac{1}{2}(34.3)(34.3)\frac{1}{3}}{74.294}$

$\qquad = 14.321$ ft. above base

Tailwater $\frac{1}{2}(22.5)^2 \, 0.0625 = 15.820$ k

Tailwater Resultant Location = $22.5/3 = 7.5$ ft above base

Additional Weight due to tailwater

$\frac{1}{2}(22.5)^2 (0.0625) = 15.820$ k

Resultant Location = $\frac{2}{3}(22.5) = 15$ ft. from toe

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Subject _Stonham Dam_
Stability Analysis
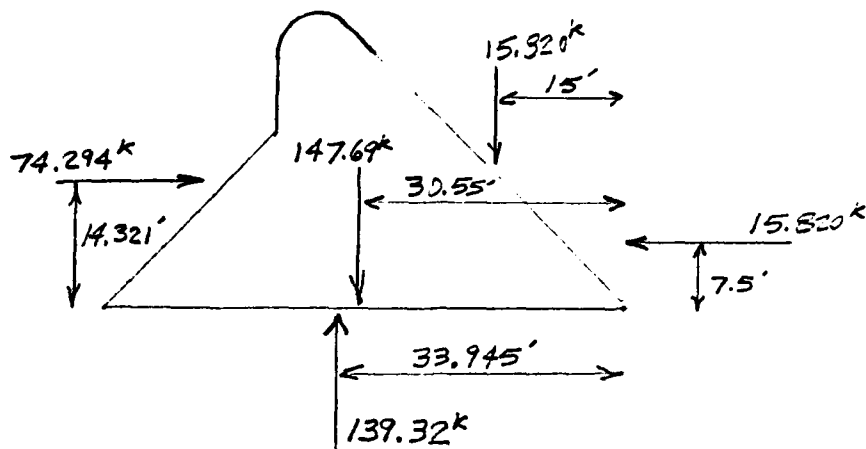_Overflow Section_
Computed by _JGU_   Checked by _GDL_

S.O. No. _13333-_
Sheet No. _7_ of _7_
Drawing No. ____
Date _June 3,_

Case IV   Loading Diagram

$$F.S._{overturning} = \frac{(147.69)(30.55) + (15.820)(15) + 15.820(7.5)}{(74.294)(14.321) + (139.32)(33.945)} = \frac{4867.880}{5793.182} =$$

$F.S._{sliding} \Rightarrow$ $\phi = 35°$ $s = 2 ksf$

$R = \Sigma V \tan\phi + sA$

$= (147.69 + 15.82 - 139.32).7 + 2(60)$

$= (24.19).7 + 120 = 136.933$

$\Sigma H = 74.294 - 15.82 = 58.474$

$$F.S. = \frac{136.933}{58.474} = \underline{\underline{2.342}}$$

Resultant Location $= \dfrac{4867.880 - 5793.182}{24.19} = \underline{\underline{-38.25 \ ft}}$

Note: Negative means the resultant is downstream
from the toe.

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